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volume 69 • number 9 **SEPTEMBER 1960**

JOURNAL of the SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

PUBLICATION OFFICE TWENTIETH AND NORTHAMPTON STREETS EASTON, PA.

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

Headquarters Office: 55 West 42d St., New York 36, N.Y. Cables: Somopict Telephone: LOngacre 5-0172

Executive Secretary: CHARLES S. STODTER

Published monthly by the Society of Motion Picture and Television Engineers. Publication office 20th and Northampton Sts., Easton, Penna. Second-class mail privileges authorized at Easton, Penna. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122.

Printed by Mack Printing Company, Easton, Pa.

Journal of the Society of Motion Picture and Television Engineers

VOLUME 69 • NUMBER 9 • SEPTEMBER 1960

Thermoplastic Recording

By W. E. GLENN

A new method is described for recording electrical signals. Information is written at extremely high density by means of an electron beam on a film consisting of a low-melting thermoplastic material. This can be projected as a full color image, or can be converted to an electrical signal. The tape, which is processed by quick heating, can be readily erased and re-used. A video recorder using this recording technique is described.

THERMOPLASTIC RECORDING is a recording technique in which an electron beam records an image on a special film that can be viewed optically. The film requires no chemical processing and can be erased and reused. The recording density is comparable to that of very fine grain photographic film. The film can be monitored and edited optically. Color images, or black-and-white, can be recorded on the film. Bandwidths in excess of 50 megacycles are probably attainable.

Recording Technique

In a previous paper[1] the basic recording technique was described. The recording principle is illustrated in Fig. 1. The film used consists of a high-melting base film coated with a transparent conductor which has a thin film of a low-melting thermoplastic on its surface. An electron beam is used to lay down a charge pattern on the surface of the thermoplastic film in accordance with the information to be stored. The film is then heated to the melting point of the thermoplastic. Electrostatic forces between the charges on the film and the ground plane depress the surface where the charges occur until these forces are in equilibrium with the surface tension restoring forces. The film can now be cooled below its melting point and the deformations will be "frozen" into the surface.

It is not necessary to develop the deformations immediately. The charges will persist for days. The film can be developed as it is projected, with a hot air blast. The advantage of developing in the recorder is that the recording can be monitored as it is made.

To erase the film the charge pattern must be discharged by heating the film well above its melting point so that its conductivity will increase. Surface tension will then smooth out the deformations and the film is ready for re-use. The film may be heated for developing the deformations in a vacuum. It must also be cooled back below the melting point before it can be rolled up. A practical way to do this is to heat only the top surface of the film by inducing current in the transparent conducting coating for about 0.05 sec. This is ample time for the deformations to form. The heat will then diffuse into the film base and the surface will cool. By confining the r-f fields, local erasure of areas a few mils square is possible if desired.

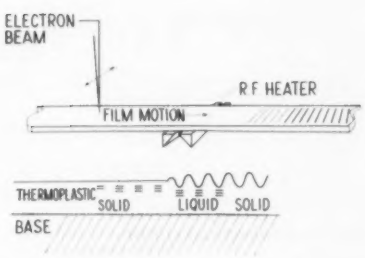


Fig. 1. Recording mechanism and cross section of tape.

Reading

Since the recorded information is in the form of ripples rather than variations in density, a special optical system must be used to produce an optical image. This is a modified schlieren optical system illustrated in Fig. 2. In this system a series of line light sources are imaged on a set of bars by the condensing lens. If there are no ripples on the film no light will reach the projection lens and the screen will be black. A ripple will refract light between the bars and allow that spot to appear as a light spot on the

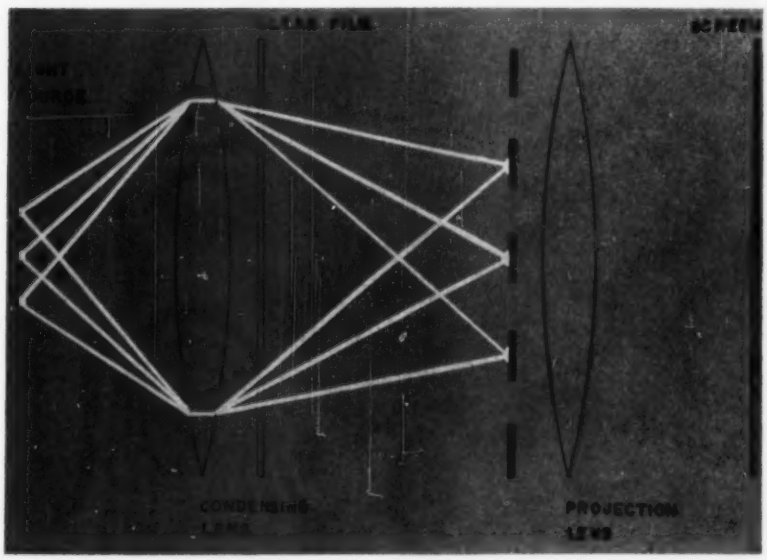


Fig. 2. Schlieren optical system for projecting black-and-white images on tape.

Presented on May 5, 1960, at the Society's Convention in Los Angeles by W. E. Glenn, Applied Physics Section, Research Laboratory, General Electric Co., P.O. Box 1088, Schenectady, N.Y. (This paper was received on July 29, 1960.)

[1] W. E. Glenn, *J. Appl. Phys., 30:* No 12., 1870, Dec. 1959.

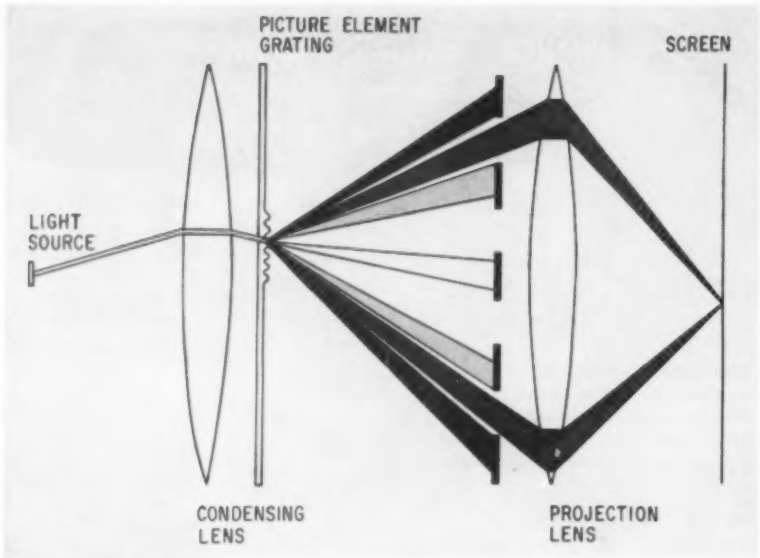


Fig. 3. Color optical system.

screen. The depth of the ripple will determine the brightness of the spot. To record black-and-white television, the electron beam simply scans a normal television line, depositing charge in accordance with the light intensity of each picture element. The charge density will govern the depth of the resulting deformation, and upon projection the light intensity of the picture element will depend upon this depth.

For color imaging the deformations are impressed on the thermoplastic surface in the form of phase diffraction gratings. The optical system described in a previous paper[2] permits projection of a color image from such a pattern of gratings. This system is illustrated in Fig. 3. In this projector a condensing lens near the film images an array of line light sources on a set of opaque bars in front of the projection lens. Where the film is smooth these bars intercept the light and these areas appear black on the screen. In an area where the deformations form a diffraction grating, light will be diffracted through the slots and the projection lens will image this light at a position on the screen corresponding to the position of the grating. The slots are narrow enough to admit only one of the primary colors of the spectrum that fall on the bar system. The spacing of the grating determines the color of the picture element. The amplitude of the grating determines the intensity of the diffracted light.

For color image reproduction more than one primary color is necessary. A color which is the sum of two or more primary colors can be formed by simply superimposing two or more gratings, each with a spacing corresponding to a primary color.

Although reading the film in the form of projected images is illustrated here, it is obvious that these can be converted back to electrical signals by standard scanning techniques.

[2] W. E. Glenn, *J. Opt. Soc. Am.*, *48:* 841 (1958).

Video Recorder

A video recorder illustrated in Fig. 4 has been constructed. In this recorder the film plays off a reel and passes under the electron beam. The electron beam scans in the horizontal direction only, the vertical scan being produced by the film motion. The beam is modulated by "wobbling" it with the i-f signal from the television set at about a 1-volt level. This effectively defocuses the raster lines in the black areas of the picture. The film then passes over an r-f heater and an optical monitor, and then rolls up on another reel.

The recorder is evacuated to a pressure of about 0.1 micron. The roughing and high-vacuum cycle sequences automatically with a total pump-down time of about one minute. The recorder uses 16mm film base with 8mm perforations. The image sizes are either 4 by 5-mm (8mm frame size), or fully resolved 2 by

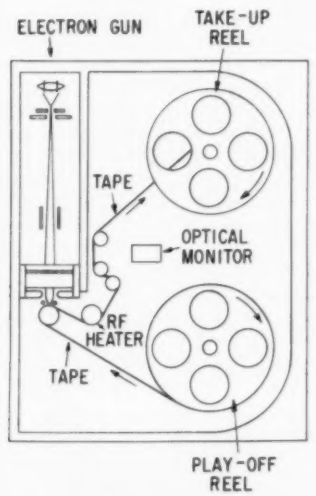


Fig. 4. Video thermoplastic recorder.

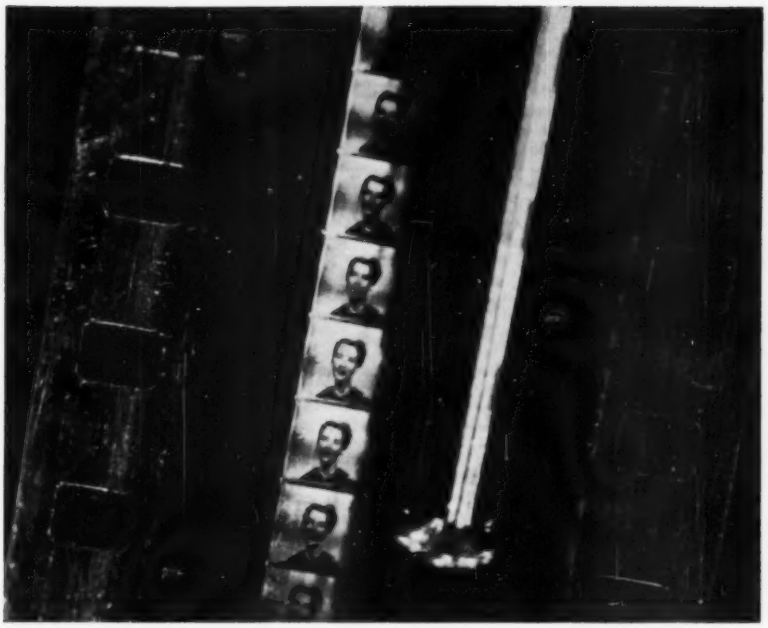


Fig. 5. 2 by 2.5-mm frames recorded on thermoplastic tape compared with an ordinary straight pin.

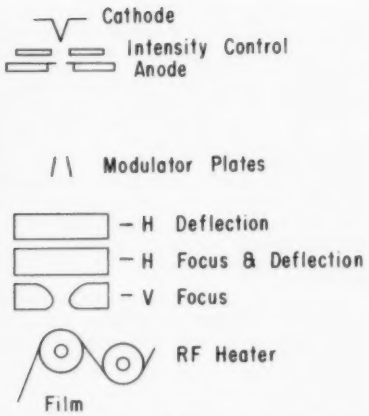


Fig. 6. Schematic of electron gun for video recorder using crossed cylindrical lenses.

2.5-mm frames can be recorded. These frames should technically be called fields because of interlace. Figure 5 shows a series of 2 by 2.5-mm frames compared with an ordinary straight pin.

Electron Gun

A schematic drawing of the electron gun used in the recorder is shown in Fig. 6. This uses crossed cylindrical lenses in order to take advantage of the fact that it scans in only one direction. It uses electrostatic focus and deflection and produces a spot size of 4 by 6 microns.

Discussion

Kenneth K. Kaylor (*Allen B. Du Mont Laboratories*): Was the apparent 60-cycle hum in the film inherent with the machinery or did it come from the receiver?

Dr. Glenn: The effect you noticed was 120-cycle. We don't know where it came from. There was some vertical shading due to some hum somewhere.

Mr. Kaylor: Is this inherent in the recorder or is it from some outside source?

Dr. Glenn: It is not inherent in the recording process. I don't really know where it came from in the circuit.

Al Kallman (*Visual Electronics*): The film seemed to be drifting up and down; what would cause this?

Dr. Glenn: This apparent drifting could be caused by the inaccuracy in sprocketing mentioned earlier.

Mr. Kallman: Would that cause not only the jitter but the drifting itself?

Dr. Glenn: If the film appeared to drift continuously it may be because here we are running the recorder on a synchronous motor; in that way we get the vertical sweep. This may have been a program from outside New York on a slightly different line frequency. In that case it would not be synchronous.

Anon: Have you considered the development of a system without vacuum, particularly for military systems where the changeover (taking a reel out and then putting it back in and then sucking the vacuum down) introduces enough of a delay to be somewhat objectionable to military display systems?

Dr. Glenn: A number of systems have been studied. Generally the problems of a vacuum are much less than the problems involved with any of the other systems that have been considered.

Anon: Have you considered the use of other tubes such as the Litton-type electrostatic tube or, let's say, the A. B. Dick Videograph type of tube, and charging your tape from that type of tube?

Dr. Glenn: This would raise a number of problems. This question is too involved to go into here at any length but it can be said that you get into a lot of trouble trying to do it out in the air.

Anon: Would there be any problem in running tape as wide as two or three inches, still in a vacuum but running it in this same system?

Dr. Glenn: Running the film is no problem. Being able to scan that width with a 5-micron spot I think might be a problem.

Don Anderson (*KRON TV, San Francisco*): Can this be read out electronically?

Dr. Glenn: Not directly. We just scan it out the way you do a kinescope film. I think it should be fairly easy to track the line so that you can get an electrical signal out but this would not be scanning the film itself directly.

Mr. Anderson: Can you recover an electrical signal without going through optics?

Dr. Glenn: No, it would be necessary to go through optics to do it.

Mr. Anderson: Is there no way of detecting this charge or has the charge disappeared by the time you play it back?

Dr. Glenn: No, the charge remains for a time but this seems to be the more difficult way to do it.

Rudolf Kingslake (*Eastman Kodak Co., Rochester, N.Y.*): In reference to the optical reproduction of the picture, you said that the depth of the ripples determines the brightness of the image on the screen. It seems to me that the *slope* of the ripples' sides would determine the brightness rather than merely the depth.

Dr. Glenn: Yes, essentially that is correct. It is really the slope; for a given grating spacing, of course, this is related to the depth.

Dr. Kingslake: Is the grating spacing nothing but the scanning lines?

Dr. Glenn: It is in black-and-white. In color the carrier that produces the grating is actually generated.

Dr. Kingslake: Would that be at right angles to the original line?

Dr. Glenn: That is correct.

George Lewin (Army Pictorial Center): I understand that the filament used to project this has only four or five slots; does this mean that there is no advantage in greatly increasing the number of slots?

Dr. Glenn: On the contrary it might be a disadvantage in respect to signal-to-noise. If it is possible to refract the light that far it is better to use fewer slots because the ripples are deeper.

Mr. Lewin: If a much larger picture should be projected would the problem arise of the heat affecting the thermoplastic?

Dr. Glenn: Since the film is clear it doesn't absorb heat other than the absorption of the base, and the erasing temperature is quite high; it is likely that this would be less of a limitation than with standard motion-picture film.

Mr. Lewin: Do I understand that when the TV image is picked up, undetected i-f (intermediate frequency) is used?

Dr. Glenn: Yes: actually we are not resolving the 45 megacycles. The purpose is to wobble the spot to defocus the beam; thus where it is defocused it is black, and where it is focused it is white.

Ralph Lovell (*NBC, Hollywood*): Is it possible to make photographic prints from your thermoplastic recording and could it be done on existing motion-picture printers?

Dr. Glenn: It would be impossible to make a contact print, as such, but with a lens system in between, where one film is imaged on the other, by putting in the bars mentioned earlier, a direct print could be made.

Mr. Lovell: Would it be possible to use a photographic emulsion recorder instead of the thermoplastic recording and expose this directly with the electron beams?

Dr. Glenn: The main problem is that most of these emulsions absorb water and out-gassing them is quite a problem. By going to a system like this it is much easier to pump a vacuum. I think you probably could, but it's more difficult — from the vacuum point of view.

Tony Severdia (*Ampex Corp.*): I believe the literature has said that pulse recording, in the sense of pulse information other than pictorial information, is also possible; but, lacking electronic readout, how is this achieved?

Dr. Glenn: You can record an electrical signal and then scan out an electrical signal — so, if these happen to be pulses, they'll come out

pulses. There is an optical step in the middle but it doesn't really degrade the picture.

Mr. Severdia: How would the readout be accomplished?

Dr. Glenn: For example, with a flying-spot scanner, the lines can be individually scanned.

Les Goldman (Quartet Films): Is it possible to record single-frame exposure with this device?

Dr. Glenn: Yes.

Sidney Sternberg (RCA Astro-Electronic Products): What is the chief factor limiting the resolution?

Dr. Glenn: Probably the wavelength of light because it must be read out optically.

Dr. Sternberg: Is there a problem with the electron beam?

Dr. Glenn: No, electron beams can be much smaller than the wavelength of light. There are other factors, but for practical purposes the size of the picture is much more of a limit. There is the problem of getting enough light through it if, for example, it is to be directly projected.

Dr. Sternberg: It is understood that the electron beam can be focused, but does this operate over the complete frame of the scan?

Dr. Glenn: This would depend on how far you want to scan. The scanning is generally limited to a certain number of spot diameters reflection, almost regardless of the spot size.

Dr. Sternberg: Are there limitations in the deformation of the materials, as far as resolution is concerned?

Dr. Glenn: I'm not sure about that. We haven't really pushed it to the wavelength of light quite yet.

Dr. Sternberg: What is the limiting factor on signal-to-noise?

Dr. Glenn: Usually dust in the film, or imperfections in the film. It's roughly comparable to photographic film in this respect; scratches and dust and other imperfections will show up on the screen.

Dr. Sternberg: How many gray levels can be recorded?

Dr. Glenn: This is relevant to signal-to-noise. I don't have a very accurate figure on that — you observed the black-level ratio on the screen — your guess is as good as mine.

Don Peterson (North American Aviation): Could you say at this time if it is possible to increase the recording speed and thereby gain some time magnification?

Dr. Glenn: Recording at quite high bandwidths is possible, for example, 50 megacycles is quite practical.

Mr. Peterson: Then 50 megacycles is desirable?

Dr. Glenn: Yes.

John T. Mullin (Minnesota Mining & Mfg. Co.): Was the image on the film a 0.1-in. or 0.2-in. image?

Dr. Glenn: That was an 0.2-in. image, and therefore brighter than the smaller image.

Mr. Mullin: Is the method in which the light is diffused a function of the sharpness of the horizontal sweeping line?

Dr. Glenn: Yes.

Mr. Mullin: Then going from white to black is accomplished by, in effect, defocusing this line, by going from a sharp ridge to a flat surface?

Dr. Glenn: This is one way; there are several ways of modulating but that seemed the most desirable method.

Mr. Mullin: Is it strictly variation of the amplitude of the i-f carrier which affects the beam so that the general result is one of defocus where the amplitude is large in contrast to sharp focus where it is small?

Dr. Glenn: That's right. Fortunately, TV is modulated the right way in the United States for our purposes.

Rolf A. Seitle (Philco Corporation): This is a velocity-modulated beam, is it not?

Dr. Glenn: Not in black-and-white. In color it is.

Mr. Seitle: Could this be considered, in some respect, a turnaround of the old Eidophor principle?

Dr. Glenn: There are certain resemblances but this is primarily a recording system. It can be modulated in the same way as the Eidophor.

Mr. Seitle: Was an amplitude beam or a velocity-modulated beam used in producing the examples shown here?

Dr. Glenn: Neither; the beam is focus-modulated.

Mr. Lovell: Can you give us an idea when this technique will be commercially available to the industry?

Dr. Glenn: I have no idea.

Exposure Control in Television Film Recording

By RODGER J. ROSS

Attempts to "improve" the picture quality of film recordings by adjustments of recorder setup or modifications of the film process have produced, in general, disappointing results. The advantages of a constant density and density difference film process are outlined. Sensitometric analysis of film response characteristics and exposure conditions may be employed for accurate control of image formation. A linear overall transfer characteristic may be achieved by selecting the most favorable operating conditions in reference to a standardized telecine reproducing condition. To maintain these conditions, a sensitive and accurate photometer is required, together with a standard reference staircase signal. The paper describes the design and use of a photometer utilizing a modified Densichron amplifier and probe, and a calibrating light source.

IN THE RECORDING of television programs on motion-picture film, known in different parts of the world as kinerecording, teletranscription, telerecording, or simply TVR, the ideal situation is a linear transfer process in which the video signals at the output of telecine reproducing equipment are identical with the signals at the input to the recording equipment. Although film recording is more often looked upon as a means for producing low-grade motion pictures, and the exposure or development of the film is often adjusted in attempts to produce the best possible subjective appearance of picture images, it can be shown that a linear transfer film process may be set up and maintained by taking advantage of the inherent reproducibility of photographic image formation. In brief, if the film is always subjected to the same degree of exposure and if the degree of development remains constant, the same magnitude of silver blackening or density will be obtained. However, precise control of a large number of variables is required if a constant relationship is to be maintained between the magnitude of the film record at every point and the corresponding amplitude of the video signal from which the record is made.

Photographic image formation is a two-stage process in which exposure produces minute changes in the silver halide crystals of the film emulsion, forming invisible latent images that may subsequently be converted into masses of black silver grains by the chemical action of the developing solution. The nature of the images may be altered significantly by variations in either exposure or development, but these alterations are by no means complementary. For many purposes, particularly when the photographic process is utilized to produce visually acceptable images of real objects or scenes (including motion pictures), it is often possible to enhance the subjective response by judicious modification of film treatment.

Presented on May 5, 1960, at the Society's Convention in Los Angeles by Rodger J. Ross, Canadian Broadcasting Corp., 354 Jarvis St., Toronto, Canada.
(This paper was received on June 15, 1960.)

Film as a Storage Device

In most cases, television engineering groups are responsible only for the exposure of the film in recording equipment, and the exposed film must be sent to commercial motion-picture laboratories for processing and printing. The fact that the film provides only a means for storing video information for subsequent recovery in the television system has all too often been overlooked or completely disregarded. The idea that a TV film recording should have best possible picture quality, judged by observation of projected light images, has given rise to a situation in which

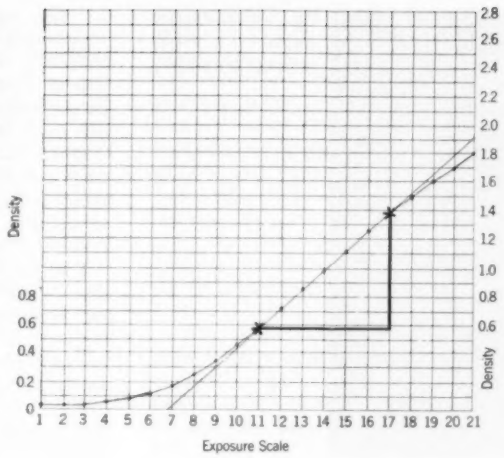


Fig. 1. Characteristic or H & D curve of Eastman 7374 television recording film, exposed in a Type 1B sensitometer and processed in a modified D76 developer. The points marked on the curve indicate the densities selected for calculation of gamma. The characteristic curve is drawn only when necessary, as in analyzing differences between film batches.

the most frequent complaint is extreme variability of the results. Modifications of the film process in attempts to improve picture quality have undoubtedly contributed materially to this situation. Worse still, these efforts at least partially mask the effects of defective video feeds to recording equipment and interfere with normal television fault-reporting and tracing procedures.

The alternative is a rigidly controlled film recording process. Such a process has been in continuous operation at Toronto, Canada, the major English language programing center of the Canadian Broadcasting Corp., since early in 1954. It has been demonstrated conclusively that a controlled film recording process can be readily achieved and maintained in practice at a rate of approximately half a million feet per week, within small tolerances. This recording installation includes a film processing and printing laboratory, under the control of the same television engineering group responsible for the exposure of the film in recorders and for the playback of recordings in telecine equipment.

The Basic Transfer Process

In the recording of video signals on film, variations in the level of the signals must be converted first of all into variations in the emission of radiant energy by the phosphor in a cathode-ray tube. As the scanning beam traverses the face of the tube, the moving spot of light is focused by a lens on the film in the camera gate, to produce invisible latent images. After processing, the black silver images will impede the transmission of light through the film, and with the images sharply focused on a TV camera tube, the video signals may be recreated.

In practice, at least one additional photographic step is usually employed. The photographic process normally produces negative images in the camera film; that is, the masses of black silver grains are greatest at those points in the film receiving the highest levels of exposure. To obtain positive images, the process must be repeated. In motion-picture work this is done by passing the negative over an illuminated aperture in contact with a strand of positive raw stock, in a machine known as a printer. The black silver images in the negative modulate the light beam to produce latent images in the positive film. These latent images are then converted to black silver by a processing procedure similar to that used for the negative, except that higher contrast is usually required.

In a conventional negative-positive recording process, control must be applied to two stages of exposure, and two stages of development, for each of which a different set of conditions must be maintained.

Major Variables of the Image Forming Process

The way in which a photographic material responds to exposure and development, or the influence of different conditions of exposure and development upon image formation, may be evaluated by sensitometric analysis. To make such an analysis, a sample of the material is exposed in a sensitometer and processed; then the densities of the various steps of the resulting image are measured with a densitometer and plotted on graph paper against the corresponding levels of exposure, in order to obtain the characteristic curve. The shape of the characteristic curve and its location on the graph in relation to the exposure scale will vary with exposure and processing conditions and with the film stock itself. Thus, sensitometry may be utilized to evaluate the three major variables of the photographic image-forming process:

(a) the response of the material, exposure and processing remaining constant;

(b) the influence of variations in processing under fixed exposure conditions; and

(c) the influence of different exposure conditions while processing conditions remain constant.

To evaluate processing conditions, strips of film exposed in a sensitometer are processed at frequent intervals. With film taken from a single batch, and with fixed exposure conditions in the sensitometer, any variations in the densities of processed test strips would obviously be due to changes in image-forming conditions in the processing machine.

Simplified methods of evaluation of image-forming conditions, and the application of sensitometric control data in the operation of a precisely reproducible film process, have been described in a paper in the *Journal*.[1]

Basic Requirements of Exposure Control

The first and most important requirement of a controlled film recording process is precisely reproducible processing conditions. If the same measured level of exposure on the film will not always produce the same density, within a reasonable tolerance, it is futile to attempt to control exposure.

For a particular fixed condition of processing, the characteristic curve illustrates the manner in which density increases with increasing exposure. This is shown in Fig. 1. The standard method of exposure in the sensitometer consists of exposing the film in steps, usually 21, with the exposure level increasing by a constant factor of $\sqrt{2}$ for each step.

The response of any film stock normally varies considerably with differences in exposure conditions. Failure of the reciprocity law is a well-known example. According to the reciprocity law, $E = It$; that is, the degree of exposure (and presumably the resulting density after processing) should remain the same whatever values of intensity and time may be used, providing the product remains constant. This of course does not hold true in practice.

Another example is the difference in response of a film between daylight and tungsten exposure conditions. Each type of film has a certain degree of sensitivity for the various colors making up the visible spectrum, as well as for radiant energy outside these limits. Consequently, as the color of the exposing light varies, the resulting density in the film will vary also. Because so much film is used to take pictures under normal outdoor and artificial light conditions, the photographic industry has selected representative conditions of these two types as references, and sensitometers are usually designed to simulate these conditions for the testing of the response of films.

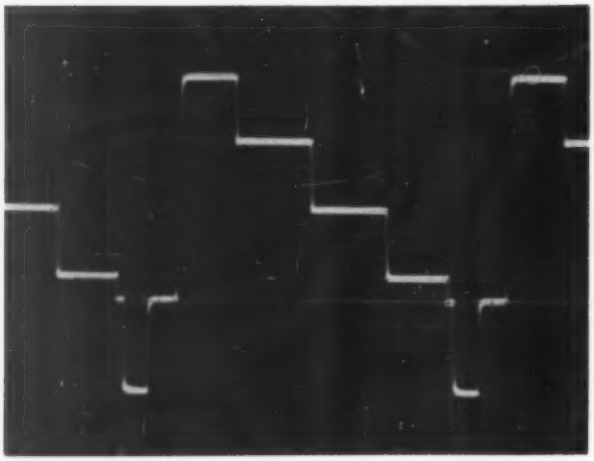


Fig. 2. Oscilloscope display of a 4-step staircase test signal.

Film Response in Recorders

Exposure conditions in a TV recorder camera differ radically from those in a sensitometer, for either daylight or tungsten illumination, and consequently the response of the film may be expected to be different also; in other words, the characteristic curve obtained with a particular type of film stock in a sensitometer is not likely to indicate the actual response of the film in the recorder camera. It would be very difficult, of course, to simulate recorder exposure conditions in a sensitometer, and in any event the market for such a device would be very limited. The obvious answer to this problem — which, by the way, is common to all specialized photographic applications in which an exposure meter and the familiar film exposure index cannot be employed — is to compare the response of the film in the recorder camera with its response in the sensitometer.

To make such a comparison, it is necessary first of all to devise a method of measurement of recorder exposure conditions. The camera lens images on the film the rapidly moving spot of light on the face of the cathode-ray tube. The time of exposure is related therefore not to the period required to scan a full frame, but rather to the interval in which the phosphor emission rises to its maximum level and then decays to zero (t). The equivalent of I in the exposure formula is the photographically effective luminance of this spot. This in turn is related to beam current.

Although measurements of beam current are sometimes utilized in exposure control, the emission of light by the cathode-ray tube is by no means constant for a given value of beam current. Also some form of static test signal is necessary, at a level which can readily be duplicated, to raise the beam current to the required value.

Measurement of light output by the tube phosphor is now the generally preferred method for setting up exposure control in recorders. A great variety of different measuring methods have been devised for this purpose. One of these will be described here. First, however, some consideration must be given to the various factors influencing the choice of density levels required in the film.

Staircase Test Signals

In a linear transfer recording process the video signal at the output of the reproducing equipment should be a replica of the signal at the input to the recording equipment. An excellent test signal for this purpose is provided by a staircase generator. Figure 2 shows an oscilloscope display of a 4-step staircase signal, used as a reference for alignment purposes. When the staircase signal is applied to the cathode-ray tube of the film recorder, a gray-scale wedge appears on the face of the tube, and the luminance levels of the various steps may be measured with a photometer.

From time to time, proposals have been made that only the straight-line portions of characteristic curves should be used in film recording, in order to minimize distortion of the gray scale. These proposals have apparently been made on the assumption that the positive print characteristic should be a straight line. This assumption can readily be shown to be incorrect. In any event, owing to the flare factor, straight-line portions of characteristic curves are nonexistent under practical conditions of exposure in which optical systems are involved.

Selection of Film Characteristics

There are no generally recognized industry standards for image densities or density range in TV film recording. Some attempts have been made to specify maximum and minimum densities of significant image areas for TV films. It is impossible, however, to apply the idea of significant image areas in TV film recording. As a result, each organization taking up film recording is obliged to select its own operating conditions, based all too often upon subjective judgment of pictures. The relative merits of any particular set of end densities and density range would be very difficult to demonstrate. In any event, a much more serious problem is to maintain the selected densities within reasonable limits.

In a paper in the *Journal*,[2] Murch has described the use of a 10-step staircase test slide to obtain a linear waveform display with vidicon telecine camera chains, and thus provide film reproducing conditions that can readily be duplicated.

Figure 3 shows, in curve C, a plot of the densities of the steps of this slide against output levels of the telecine chain. This curve provides the necessary information as to the shape of the required positive print characteristic, for it is only under these conditions that a linear output waveform will be obtained from a linear input signal. Curve B illustrates the close agreement that can be obtained with a practical film recording process. This curve shows a typical operating condition, but it will vary with different cathode-ray tubes.

In 1954, as the result of an engineering investigation of the film recording process at the Canadian Broadcasting Corp., Toronto, maximum and minimum positive print densities of 1.85 and 0.25 were selected as the most favorable end points. To obtain these densities with a positive processing gamma of 2.65, it was found that the negative must have maximum and minimum densities of 1.0 and 0.15. At that time Eastman Fine Grain Sound Recording Film, Type 7373, was in general use for film recording. Subsequently Du Pont 824 and Eastman

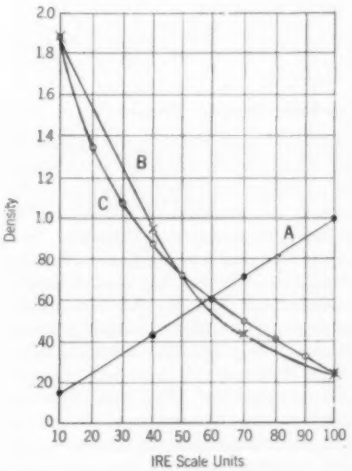


Fig. 3. Graph showing densities vs. video signal levels for (A) negative, (B) positive print from negative and (C) standard telecine transfer characteristic.

Television Recording Film, Type 7374, film stocks have been used with no alteration in maximum and minimum negative densities. Processing gamma for the negative film is 0.90, to avoid excessive drive on the cathode-ray tube; that is, the maximum negative density is obtained with less drive by raising negative gamma above the normal motion-picture value of 0.65.

The number of steps in the staircase generator signal used to set up recording equipment has been reduced to four to simplify photometer measurements on the face of the cathode-ray tube and density measurements in 16mm film frames. It should be noted that to obtain curve *B* in Fig. 3, no gamma correction is employed in the recorder. Closer agreement of curves *B* and *C* might be obtained by means of gamma correction circuits, but the degree of correction would have to be variable to compensate for differences in cathode-ray tube characteristics.

Curve *A* in Fig. 3 is a plot of negative density vs. video input level, indicating that whatever the response curve of the negative film may be to exposure conditions in the recorder, it must be very nearly complementary to the signal level vs. effective luminance output of the cathode-ray tube. Curve *B*, obtained by printing the 4-step negative wedge shown in *A*, corresponds closely to the characteristic curve of the positive film stock. The greater part of the curving toe of the positive, toward the right of the illustration, is utilized, as well as part of the straight-line portion, toward the upper left, in the direction of maximum density.

Recorder Line-up Procedures

The output of the staircase generator must be very carefully standardized to provide a reference signal for setting up and controlling the recording process. If the amplitude of the signal varies, incorrect line-up of recording equipment will result. At Toronto the staircase generator is installed in a rack in Master Control, where the operators are responsible for feeding a standard signal at all times to the recording room. The 4-step signal is available throughout the working day at each recorder on a relay switching panel. A Tektronics scope is provided for checking the reference signal prior to use. Figure 4 is a general view of the Toronto film recording room. GPL video recorders are used, together with synchronously operating Reevesound PVR 100 magnetic film recorders for the sound. The GPL recorders are fitted with 10NP 11 cathode-ray tubes.

A preliminary step in lining up a film recorder for operation is the calibration of the recorder monitor scope. It is on this scope that critical evaluations are made by the operator of incoming program signals, in reference to the scope calibration.

The staircase signal, with sync and setup stripped off, is applied to the grid of the cathode-ray tube. Zero signal is now the black, or first step of the wedge. The amount of d-c bias applied to obtain the required minimum luminance level establishes the point on the tube characteristic at which the adjusted zero level in the video signal will be located. The minimum luminance level must be adjusted to produce the desired minimum density in the film. The actual luminance level required will depend, among other things, upon the aperture at which the camera lens is set, and of course upon the sensitivity of the film. To avoid the need for excessively high luminance levels on the cathode-ray tube, the camera lens must be set close to maximum aperture with available film stocks. The aperture used at Toronto for Eastman 7374 film is $f/3$.

It is particularly interesting to note that in establishing a minimum density on the film in this way, it is the d-c bias applied to the cathode-ray tube that establishes the condition of minimum luminance in the first, or black, step of the wedge. This minimum luminance is well above visual black. Because this level of luminance is set by the d-c bias, the tube will not go completely black when the video signal is cut off, but will continue to emit light at this minimum level. Consequently, a uniform veil of density at the level selected as minimum for the process is laid down on the film at all times. This means that the density scale or range of recorded picture images does not begin at base density, as in other more familiar photographic applications, but rather at the selected level of minimum density. This density level will be found at all points in recorded images at which the signal level falls to zero, as in the darkest parts of clothing, and other shadow areas.

Sync and Setup Stripping

Extreme care must always be taken in feeding a standard reference staircase signal with 10 IRE units of setup to the recording room and in adjusting the sync and setup stripping controls in the calibration of the recording equipment. If a small amount of setup is inadvertently left on the staircase signal because of inaccurate setting of the stripper controls, the black, or first step, signal level on the cathode-ray tube characteristic will be incorrect. Under ideal line-up conditions, identical luminance levels should be found on the tube where the black step of the wedge appears, with or without applied signal.

There is still another very important

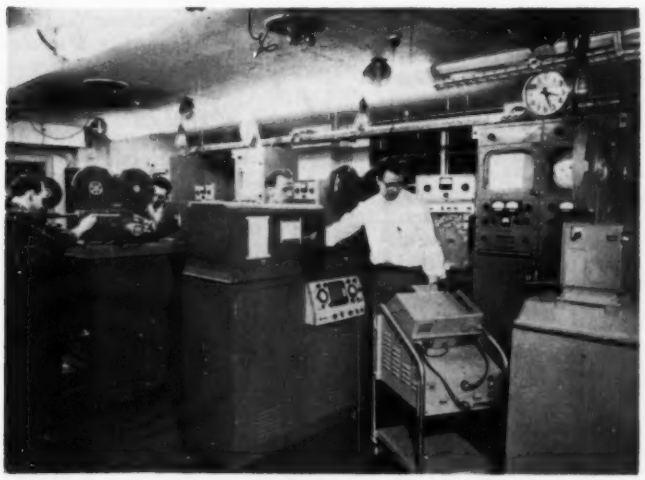


Fig. 4. General view of CBC, Toronto, film-recording room, showing an operator setting up a recorder with the photometer.

Fig. 5. Video recorder photometer. Probe fits in a mount on front of dolly when not in use.

Fig. 6. Video recorder photometer in use. The operator is setting recorder bias and video gain controls to produce required photometer readings.

reason for precise adjustments of sync and setup stripping controls. After the calibration of the recorder has been completed and the staircase signal has been replaced with program signals, sync and setup will be stripped off at the same level, and the program signals will be applied to the cathode-ray tube at the same bias level. Any discrepancies in settings of the controls will obviously cause the adjusted zero signal level to depart from the selected bias level on the tube characteristic. If stripping occurs *below* electrical black level in the program signals, that part of the setup remaining will increase the minimum density in the film; if stripping occurs *above* program-signal black level, portions of the black information will be stripped off as well, resulting in loss of detail in picture shadow areas. These are the main reasons for the extreme sensitivity of the film recording process to slight variations at the black end of the picture scale.

Video Gain and White Level

When zero signal level on the cathode-ray tube characteristic and minimum density in the film have been established with the d-c bias control, drive must be applied with the video gain control to produce a level of luminance on the face of the tube that will result in the desired maximum density in the film. The difference between the two resulting points on the tube characteristic is the video swing, and the difference between the minimum and maximum densities on the film is the density range. Within these limits, all program signals will occur, and all image elements must be reproduced. The actual value of d-c bias and video gain employed will vary with changes in operating conditions, such as the differences between phosphors when cathode-ray tubes are changed, aging of tubes and differences in film sensitivity between batches. However, the densities on the film representing black level and peak white must remain constant, and the bias and video gain controls must be adjusted as required to compensate for changes in operating conditions and to maintain these densities at predetermined levels.

Video Recorder Photometer

The requirements for a very sensitive light meter to enable setting up recorders with greatest possible accuracy brought about the development of a special unit (Fig. 5), utilizing a modified Densichron amplifier Model No. 38312 and a blue probe No. 3831A.* In addition to these components, the video recorder photometer contains a calibration light source, power supply and calibration lamps, mounted on a modified oscilloscope dolly.

The probe is fitted in a mount containing a blue filter which is used to modify the spectral response of the photocell to approximate that of the film stock used for recording. The filter is mounted between two pieces of opal glass in front of the photocell, serving as a secondary light source. The opal glass diffuses the line structure on the face of the cathode-ray tube and acts as a pulsating light source. The rate of pulsation is 60/sec, the television field rate. The 60 pps (pulses/sec) waveform developed across the plate load of the photocell is modulated to a certain extent by 24 pps produced by the electronic shutter in GPL recording equipment.

In the Densichron probe the photocell is mounted between the poles of an electromagnet. This is energized only during the calibration process, by means of a microswitch.

The Densichron amplifier uses an a-c feedback circuit with five amplification stages. Between the third and fourth stages, a 120-cps tuned circuit is used to obtain a sine wave from a 120-pps signal produced by the a-c field surrounding the photocell during calibration. When the probe is held against the face of the cathode-ray tube and the a-c field is removed, the 60-pps signal drives the 120-cps tuned circuit and also produces a 120-cps sine wave. The gain is high at 120 cps and it decreases sharply on each side of this frequency.

Under the worst conditions (that is, over the picture splice), the 24-pps signal produced by the electronic shutter frequency will cause only a small fluctuation of the meter needle at full-scale deflection.

A relay is installed in the amplifier chassis to energize the probe magnet only when the probe is placed in the opening of the housing of the calibration light source. A microswitch fitted in this opening is actuated by the probe and energizes the relay switch.

The range switch on the amplifier has been labeled as a multiplier switch in units of ×0.1, ×1.0, ×10 and ×100. The meter has been recalibrated in an arbitrary scale of light units. There is no necessity in this application for the calibration of the meter scale in units of effective luminance, since the meter serves only as a reference to obtain predetermined density values in the film. In any event, as the cathode-ray tube ages, or the film sensitivity changes, the relationship of a given meter reading to density in the film will change also.

Photometer Calibration

It is very important, however, to ensure that a given condition of luminance will always give rise to the same photometer reading. This is accomplished by a regular calibration procedure. The calibration lamp is mounted in a housing with an opening into which the photometer probe may be inserted. By establishing a constant light level at the face of the photometer probe with the calibration lamp, the gain control of the amplifier may be correctly adjusted prior to use. A second microswitch, located in the opening of the calibration lamp housing and actuated by the insertion of the probe, operates a relay which turns on the calibration lamp only during use.

The calibration lamp is operated from a d-c power supply, equipped with a 0–3 d-c ammeter.

A drawer in the base of the unit provides spaces for calibration lamps, and lamp calibration data. The usual methods of photometer lamp calibration are followed to provide the reference light source.

* Manufactured by the Welch Scientific Co., Chicago, Ill.

Using the Video Recorder Photometer

Figure 6 shows the photometer being used to set up a recorder. The photometer probe is placed against the faceplate of the cathode-ray tube, and the bias and video gain controls are adjusted to obtain previously determined meter deflections in the black and white steps of the staircase wedge.

The meter deflections required to obtain the desired minimum and maximum densities with a particular film may readily be determined by a simple test procedure. With the film running in the camera, the bias is adjusted to produce small changes in the photometer reading on the black step of the staircase wedge. At each change the meter reading may be lettered on the face of the tube with grease pencil, and will thus be recorded on the film for later reference. In another test run, the video gain control should be adjusted to produce increments of increasing deflection on the photometer with the probe placed over the white step of the staircase wedge. Great care must be taken during these tests to make sure that recorder high voltage remains constant and that no changes occur in the staircase signal applied to the recorder.

After the film has been processed the densities of the black and white steps of the staircase wedge are measured with a densitometer to determine the photometer readings corresponding to the desired minimum and maximum densities. It should be quite obvious from the foregoing that if processing of the film is not rigidly controlled, a particular line-up of bias and video gain arrived at by this test procedure may not produce the desired minimum and maximum densities in subsequent recordings of programs or wedges.

Ideally, with a perfect line-up procedure, variations in the densities of the staircase wedges recorded over a period of time on a number of recorders should not exceed variations due to processing. In practice, of course, tolerances in setting exposure levels must also be allowed. With care in controlling processing and setting up recording equipment, it should be possible to maintain the maximum negative density of 1.0 within a tolerance of ±0.10 (Table I). The control of the minimum negative density is much less difficult owing to lower sensitivity to change in this region of the characteristic curve.

Table I. A Typical Recorder Setup.

Step No.	Signal level (IRE scale units)	Photometer reading	Negative density	Positive density
4	10	0.80	0.14	1.86
3	40	5.6	0.43	0.94
2	70	9.2	0.73	0.43
1	100	16.0	1.0	0.25

After the correct line-up of recording equipment has been established, the photometer readings required on each recorder to obtain the desired maximum and minimum negative densities should be lettered on a control card attached to the recorder. Until recalibration of a recorder is indicated by drifting of the negative densities outside established tolerances, operators may refer to the control card on each machine and make the necessary adjustments in the settings of bias and video gain to obtain the indicated photometer readings.

Negative Control Chart

As each negative is processed throughout the operating day, the maximum and minimum densities of the 4-step staircase wedge recorded at the head of each negative must be measured and plotted on a control chart.

Figure 7 shows a typical recorder control chart covering a twelve-hour operating period on five machines. The chart indicates that the maximum density on recorder No. 1 is drifting toward the upper limit of the tolerance. As soon as possible this recorder must be checked and operating conditions restored to normal.

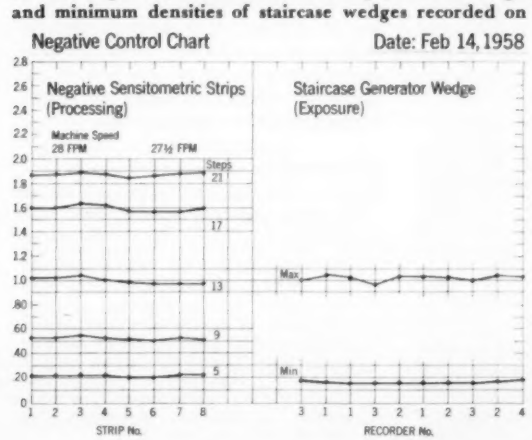
The importance of making separate evaluations of the influences of exposure and processing variations upon negative densities cannot be overemphasized. Unless processing conditions remain constant within known small tolerances, excessive variations in negative densities may be erroneously attributed to errors in line-up of recording equipment.

Recorder Exposure Control Chart

Program	Rec. No. 1 PW	Rec. No. 1 BL	Rec. No. 2 PW	Rec. No. 2 BL	Rec. No. 3 PW	Rec. No. 3 BL	Rec. No. 4 PW	Rec. No. 4 BL	Rec. No. 5 PW	Rec. No. 5 BL
Open House	.97	.17								
Newsreel			1.11	.16						
Friendly Giant							1.13	.18		
School Broadcast	1.07	.18								
Background	1.08	.18								
Tabloid									1.05	.15
Nations Business					1.07	.16				
Scan									1.09	.13
Deputy Comic			1.08	.16						
Talent Caravan	1.10	.17								
Close-up			1.11	.16						
Tennessee Ernie Ford									1.05	.18
Wrestling Part 1							1.08	.16		
Live and Learn	1.15	.19								
Wrestling Part 2					1.02	.15				
Wrestling Part 3							1.09	.15		

Fig. 7. Typical recorder exposure control chart, showing the negative densities for black level and peak white on 5 recorders in a 12-hr operating period. The data to compile the daily exposure control chart are extracted from the negative processing control chart see Fig. 8).

Fig. 8. Negative processing control chart. On the left side are the densities of selected steps of sensitometric control strips, and on the right, the maximum and minimum densities of staircase wedges recorded on the negatives.



Printer Exposure Test Chart

Date 3/12/59 — Time Processed 9:20 — Time Printed 11:52 — Operator: control JIM, printer JW

Printer No.1 Aper	Printer No.1 BL	Printer No.1 PW	Printer No.2 Aper	Printer No.2 BL	Printer No.2 PW	Printer No.3 Aper	Printer No.3 BL	Printer No.3 PW
11	1.57	.17	8	1.60	.19	10	1.57	.19
12	1.70	.20	9	1.82	.24	11	1.68	.21
13	1.83	.22	10	2.02	.30	12	1.80	.24
14	1.97	.26	11	2.17	.34	13	1.92	.28
15	2.09	.29	12	2.35	.45	14	2.08	.36

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Fig. 9. Typical printer exposure test chart. The circled entries on this chart indicate the printer light for each machine in use at which positive print densities as close as possible to the specified values may be obtained.

Figure 8 shows a simple method for separately analyzing exposure and processing variations. A sensitometric test strip must be attached to each roll of exposed negative film as it is fed into processing equipment. As processing of the day's work proceeds, the densities of a number of steps of successively processed sensitometric strips are plotted on the left side of the control chart, while the maximum and minimum densities of the staircase wedges on the corresponding rolls of negative are plotted on the right side. Thus, the left side of the chart shows processing variations only, while the plots on the right side show the results of processing together with exposure variations.

Printing Control

The control of exposure in printing is very simple compared to the line-up of recording equipment. Here it is only necessary to establish the correct level of illumination at the exposure aperture of the printer and maintain this level indefinitely. This can be done either with a photometer or by running frequent printer exposure tests. For such tests a short strip of negative staircase wedge with the standard maximum and minimum densities should be spliced in a test loop and run through the printer while the illumination level is varied in small steps until the required maximum and minimum print densities are obtained. To alter the illumination, either the light-change mechanism or the lamp current may be adjusted. After the correct printer exposure setting has been selected by test, no further adjustments should be made until later tests with the standard negative loop indicate that the maximum and minimum densities in the print have drifted out of tolerance. Of course, any variations which may be occurring in processing will affect print densities, and it would be futile to attempt to compensate for or anticipate such changes. It is essential, first of all, to provide reproducible positive processing conditions, after which correct exposure level in the printer may readily be established.

Measurements of the maximum and minimum densities of the staircase wedge in prints must be made to ensure that the entire recording process is operating in a satisfactory manner. A tolerance of ± 0.15 on the maximum print density of 1.85 can readily be maintained in practice. This tolerance includes all the variables in the entire process affecting the black end of the scale, such as the staircase generator calibration, sync and setup stripping, d-c bias setting, variations in sensitivity of the film stock, both negative and positive, variations in image-forming conditions in processing, as well as variations in exposure level in the printer. Because the minimum density occurs in the toe of the positive characteristic curve, variations due to factors affecting the white end of the scale may be maintained within ± 0.05.

The results of a typical printer test are shown in Fig. 9.

The type of operation that results from this method of printer exposure calibration is known in the motion-picture industry as "one-light" printing. Under no circumstances should "timing" of negative recordings be permitted. "Timing" is the adjustment of printer exposure level based upon subjective judgment of negative images. This technique has been successfully used for many years in motion-picture production, but it has no place in the film recording process.

Black-Level Control

Referring once more to Fig. 3, showing the relationship of video-signal input and output levels to negative and positive film densities, it can readily be seen in curve *B* that if the black level in the program signals rises to, say, 20 IRE units as compared to the standard setup level of 10 IRE units, the maximum density in the print will fall from 1.85 to 1.56. This corresponds to one full step in a 10-step staircase, as shown in curve *C*. The recording of a program under these conditions would not only appear to be flat and lacking in contrast in direct projection on a screen, but in reproducing the recording on telecine equipment the black level would have to be brought down by adjustment of the black-level control.

Program signals with 20 IRE units of setup are by no means uncommon. Under these conditions, zero signal level does not occur at the correct point on the characteristic of the cathode-ray tube, and the minimum density in the negative is not 0.15, as it should be, but 0.23. Thus the density range of the negative is reduced from 0.85 to 0.77.

A problem of an entirely different nature is encountered when the setup of incoming program signals is too low. Under these conditions, the black information in the signals is stripped off at the standard setup level, resulting in complete loss of detail in the darker portions of scenes.

Maintaining Controlled Recording

Sharply divided opinions exist as to what should be done under unfavorable circumstances such as those described. Clearly, no conceivable adjustment of the film process, in exposure or development, will compensate for the types of degradation or distortion resulting from such faults. Tampering with the calibration of recording equipment after it has been lined up with the standard reference staircase signal may occasionally result in some apparent improvement in the appearance of picture images, but then the responsibility for "quality" of recordings must be assumed by individual recorder operators.

In his classic paper in the *Journal*, Otto Schade[3] states that "the eye is not capable of performing a quantitative and objective analysis of image properties. It cannot be used at all, of course, to evaluate the quality of electrical images or image signals in intermediate stages of an imaging process, nor can it be used to evaluate or predict the effect of changes or improvements which are possible and are expected to occur upon further development of an imaging process." This quotation should be posted in every TV film recording room and in every motion-picture laboratory which processes and prints film recordings.

Summary

There are many advantages in a rigidly controlled film recording process, not the least of which is the possibility for subsequent analysis of studio operations by administrative and studio personnel. Recordings should accurately reflect deficiencies in video feeds, providing an effective means for promptly tracing and correcting the causes of faults and defects. A much more widespread awareness is needed of the exceptionally high picture quality that can be achieved under ideal conditions with the film recording process. Until a television operating group has seen a high-quality film recording, it is very difficult for the operators to assess current local production. One of the most severe problems that every recording group has to face is that a highly efficient recording process will not by itself produce good recordings.[4] Very often it is extremely difficult to convince television studio groups that video feeds must be improved. It is at this point that decisive action by management can be most effective. To raise the quality of recordings, lighting or staging practices may have to be modified; or better studio facilities may be needed. Recording groups should be expected only to ensure that the recording process is operating in a nonvarying manner. This includes, of course, the associated film laboratory operations, whether or not these operations are under the direct control of the recording groups.

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Shutter Cycles for Television Film Recording

By F. N. GILLETTE
and B. D. PLAKUN

Uniform terminology and a method of graphical representation are established. Factors affecting exposure uniformity are described by reviewing fundamental relations between the film exposure cycle and the television scan. Practical arrangements for recording television pictures on motion-picture film are described and analyzed. Effects of phosphor persistence are considered, and a detailed analysis of persistence effects in single-field recording is offered.

TELEVISION film recording starts from the television signal with its own rate of 30 frames/sec and creates from it a film record with a rate of 24 frames/sec. Popular practice is to record on 16mm film, because this size has a resolution capability adequate for most TV broadcast purposes and is much more economical than 35mm. A standard motion-picture rate is an obvious necessity in an industry which is a heavy user of conventional motion-picture film output, both new and old.

In Europe, where 50-cycle power line frequency is common, the standard television rate is 25 frames/sec, which is close enough for all practical purposes to the motion-picture rate to be regarded as equivalent. The film camera or projector is made to run slightly faster than normal, so as to produce one film frame per TV frame; but the resulting sound and motion are not perceptibly affected. Conversion from one rate to the other is therefore not a problem.

The standard American and Canadian television rate is 30 frames/sec, each frame being composed of two interlaced fields, so that the field rate is 60/sec. This standard was the subject of some debate at the time it was proposed, as the benefit of a TV rate directly equivalent to the motion-picture rate was well appreciated. However, the simplicity of receiver design that could be gained by relating the frame rate to the existing 60-cycle power line frequency outweighed other considerations.

Most of the problems of television film recording spring from the fact that a television picture on a cathode-ray tube, unlike a real scene, is not there all the time. Instead it is created line by line as the horizontal scanning line sweeps from top to bottom of the display.

With our interlaced system, one vertical sweep, which we will call the odd field, creates only half the picture. The remainder of the picture is supplied by the succeeding even field which interlaces its lines between those of the odd field.

Presented on May 5, 1960, at the Society's Convention at Los Angeles by F. N. Gillette (who read the paper) and B. D. Plakun, GPL Division of General Precision, Inc., Pleasantville, N.Y.
(This invited tutorial paper was received on June 22, 1960.)

System Classification

Intuition tells us correctly that any film recording system must expose each frame of film for some integral number of field periods in order to avoid large density jumps in the resulting film record.

The several mechanisms which accomplish this may be classified under the two general headings of single-field equipment (for which each successive shutter opening is $\frac{1}{60}$ sec, or the period of one television field) and full-frame equipment (for which the shutter opening is $\frac{1}{30}$ sec, or the period of a full TV frame). These equipments may be further subdivided into mechanical and electronic shutter classifications. It will later be shown that these equipment groups are vastly different in the way they are helped or hindered by the effects of phosphor persistence.

Full-frame systems record two fields of TV on each frame of film. This leaves 12 fields in each second that are not recorded. These omitted fields must be dropped in the smallest possible fragments to minimize motion discontinuity. All full-frame systems in use drop half of a field between each pair of film frames.

Single-field systems register only a single field on each film frame and thus have 36 unused fields to dispose of. Some do it by dropping one and a half fields between each pair of film frames. Others do it by dropping one field in one interframe gap and two fields in the next gap. The difference in motion discontinuity for these two approaches is not significant.

The full-frame system, having recorded 48 fields and dropped only 12, can be said to have recorded 80% of the information available to it. The single-field system, with 24 fields recorded and 36 dropped, has recorded only 40% of the information in the TV signal.

Here intuition says that the full-frame result should be twice as good as the single-field result, but this time intuition is wrong. The full-frame result will always be superior, but its margin may be much less than 2 to 1, depending mostly on the nature of the picture involved. In many cases the redundancy of the picture is so great that a single-field system presents everything that matters. Where this can be counted on, single-field equipment offers a worthwhile economy. For broadcast or other rigorous uses, the necessity to take what comes and do the best possible job with it would seem to dictate the use of full-frame equipment.

Shutters

A conventional mechanical shutter, properly timed in relation to the TV field, may be used to control film exposure. However, since the picture tube being photographed has its own readily controllable light source, an electronic equivalent is entirely feasible. Film exposure, in this case, is started or stopped by applying or blanking the picture on the face of the cathode-ray tube. Synchronizing mechanisms are somewhat different for the two shutter types.

The mechanical shutter rate is rigidly locked to the film frame rate, which must, in turn, be locked to the TV frame rate. This condition is simple to achieve with synchronous motor drive. In the common case where the TV camera is synchronized to the local power line, the film camera can be driven directly from this same line. Otherwise, sufficient a-c power can be synthesized from the remote synchronizing signal to drive the local camera motor. Although this is the harder way, it may be the necessary course to permit fully compatible operation from various input sources, both local and distant. In Australia, for example, where separate power networks are so numerous that some communities are served by more than one network, this type of operation is the accepted method.

The electronic shutter can be arranged to provide a consistent exposure duration of one whole TV frame, as generated by the TV synchronizing source; and can respond immediately to perturbations, within limits, in the TV frame rate relative to the film frame rate. This inherent capability is valuable for recording television program material not controlled by the local power line.

Some recording methods require very fast pulldown. Mechanical-shutter cameras with pulldown times short enough to fall within the vertical retrace period of the television sweep have been constructed and operated, but none are known to be in production in America on a commercial basis.*

* Rank Precision Industries, in England, produces a 16mm camera with a pulldown time of appreciably less than 2 msec.

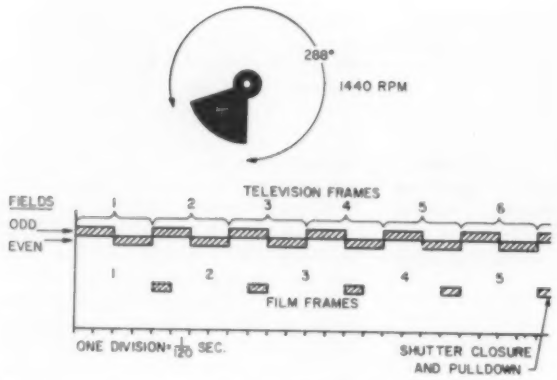

Fig. 1. Operating cycle, full-frame mechanical shutter.

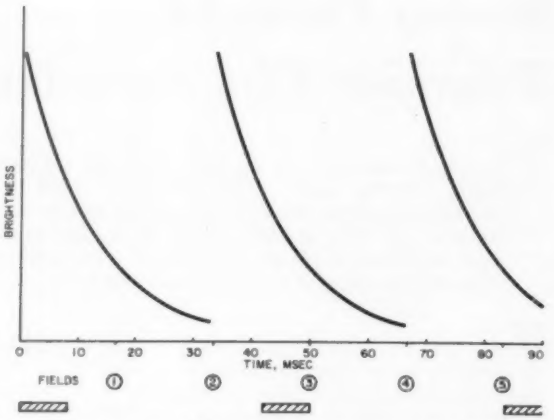

Fig. 2. Brightness pulsation cycle of a representative point due to phosphor persistence, and relation to operating cycle of full-frame mechanical shutter. Plot is for P4 phosphor. Relative phasing between the two cycles chosen at random.

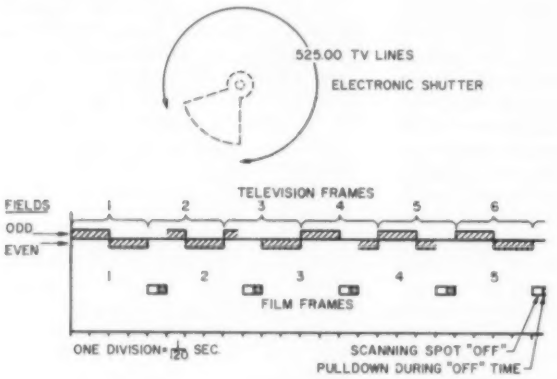

Fig. 3. Operating cycle, GPL Full-Frame Electronic Shutter.

Full-Frame Mechanical Shutter Equipment

Figure 1 is a schematic representation of the operation of a full-frame mechanical shutter equipment.

This illustration introduces a form of graphic presentation that will also be applied to each of the other situations described. The shaded blocks appearing above and below a horizontal line represent successive TV fields. The odd fields lie above the line, the even below. The brackets above this pattern group the fields into frames in an arbitrary fashion. Actually, a frame could just as well be formed of a given even field and the following odd field. The lower line of short bars represents the action of the shutter in the camera and also indicates the film frame rate. The shaded sections indicate the periods when the shutter is closed; the clear areas are the open periods. Note that this shutter is shown either open or closed, with no transition region. This is one of many permissible simplifications made to stay within a reasonable range of subject matter. In the time scale shown at the bottom, the unit is $\frac{1}{120}$ sec, a unit quite convenient for dealing with mixtures of events recurring at 24, 30 and 60 cycles/sec.

The shutter itself is shown at the top of the figure. It has a 72° blade, leaving a 288° open sector. Since it rotates at 1440 rpm (24 rps) it has an open period of four scale divisions and a closed period of one division. Thus, two fields are recorded, half a field is skipped, two more are recorded, and so on.

The time of the half-field which is skipped is not wasted. Indeed, its existence is most fortunate. This is the period used for film pulldown, and it is barely long enough to serve, requiring for the purpose very special camera movements.

In Fig. 2, the repeated curve shows a realistic plot of the light output or instantaneous brightness of some particular spot on the phosphor of the cathode-ray tube as it is excited by the TV raster. From a peak amplitude which occurs as the scanning beam passes over the spot, the brightness decays along an approximately exponential curve through the entire period of the TV frame. Then, $\frac{1}{30}$ sec later, the scanning beam returns and restores the brightness to full amplitude. This cycle repeats regularly. The lowest line again represents the intervention of the mechanical shutter of the camera.

The exposure which causes the response of the film is the illumination reaching the film, times the time during which it gets there. Film illumination is proportional to source brightness. Thus, a value indicative of exposure can be obtained by integrating the brightness plot over the period of the shutter opening; that is, we measure the area under the brightness curve, starting where the shutter opens and stopping where it closes. Since the curve repeats every $\frac{1}{30}$ sec and since the shutter is open for exactly $\frac{1}{30}$ sec, it is clear that the instant at which the period of integration starts does not matter. So long as the period is exactly $\frac{1}{30}$ sec, it will include one complete cycle of the phosphor's decay curve and the integrated exposure will always have the same value.

Note that this statement is not dependent upon the exact decay characteristic of the phosphor. It would thus seem that any phosphor, whether of long or short persistence, could be used with full-frame mechanical shutter equipment. In essence this is true. However, a more refined analysis, including the effects of erroneous shutter timing, reveals some advantage in the use of a longer rather than a shorter persistence phosphor.[1]

Electronic Shutter Equipment

Electronic shutter equipment as represented by the GPL Video Recorder[2] uses a fast pulldown intermittent mechanism with a 29° engagement which requires only 40% of the available half-field interval to transport the film. The remaining 60% of the interval is dwell time, which will be referred to later.

This system has no shutter at all in the camera, using instead control of the cathode-ray tube beam to limit the exposure. The operating cycle is shown in Fig. 3. Upon completion of pulldown, after the film has really stabilized in the aperture, the camera generates a start pulse. This pulse turns on the cathode-ray tube beam coincident with the start of the next following horizontal scanning line and simultaneously starts counting horizontal line periods. After exactly 525 of them, the counter circuits turn the beam off. After a short interval, when the

light output of the cathode-ray tube has approached extinction, the camera transports a fresh film frame into the gate and the cycle repeats.

As shown in Fig. 4, the phosphor used has a desirably rapid decay rate, the persistence illumination dropping to a very small percentage of initial value within the period of a few scanning lines.

Figure 5 is another representation of the timing cycle of the electronic shutter equipment. The top line shows the blanking waveform which turns the scanning spot on for the precisely measured period of 525 lines. The next line shows the period during which film remains stationary in the gate, that is, the period in which the film integrates light from the phosphor to determine the total exposure. The small negative segment of this waveform indicates the period during which film is in motion for pulldown.

The lowest line of the diagram is a brightness plot of the first and last lines of the 525. The integration period for the first line is about 35 msec, which is sufficient to include practically the entire light output of the phosphor. The integration period for the last line is clearly inadequate to receive all the persistence emission from the phosphor.

Exposure for the other lines of the scan lying between these two is shown in Fig. 6. The total exposure of the first line, shown at the extreme left, has been set arbitrarily at 100%. The exposure of the last line, shown near the right edge, is approximately 92%, which indicates that the exposure difference between the lightest and darkest line of the frame is only some 8%; this value can readily be compensated by a simple additive voltage applied to the cathode-ray tube grid.

If the dwell time following the occurrence of the last line were to be reduced to a significantly shorter value, it is obvious that the exposure error would rapidly increase and might very soon reach a value at which compensation would no longer be possible.

Single-field electronic shutter equipment need not be considered in any great detail. The cycle is similar to that just described for the full-frame electronic shutter equipment except, of course, that only one field is presented. Since an entire field is available for pulldown, it is easy to provide a sufficiently long dwell to extend the integration interval to practical completion.

Single-Field Mechanical Shutter Equipment

In the single-field mechanical shutter class of equipment, four types will be described. The units discussed here were selected because they are relatively familiar and also because each represents a significantly different mode of operation.

The first is one of several types of Telecorder mechanism described in a patent issued to Earl W. Daugherty.[3] Film is pulled down at a steady 24-frame rate, but the disc-type mechanical shutter is driven at a varying rate which creates alternate closures of one field and two fields, respectively. Each open period is $\frac{1}{60}$ sec. As Fig. 7 indicates, each film frame receives direct illumination from one complete TV field, as well as afterglow illumination from the preceding field. By proper phasing, exposure of each film frame starts as the TV field starts, so that the splice region is hidden in the vertical blanking interval.

Even with the splice hidden as described, provision is allowed for compensation, which may be effected by using a sawtooth waveform synchronized to the camera, to obtain essentially even illumination from top to bottom of the scan.

The second mechanism is the Television Specialties Camera described by Crusinberry and Greenhill.[4] It eliminates a splice in the visible picture area in a different manner. The shutter, shown in

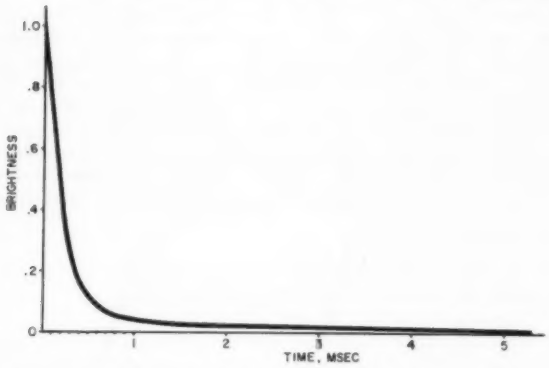

Fig. 4. Decay characteristic of P11 phosphor.

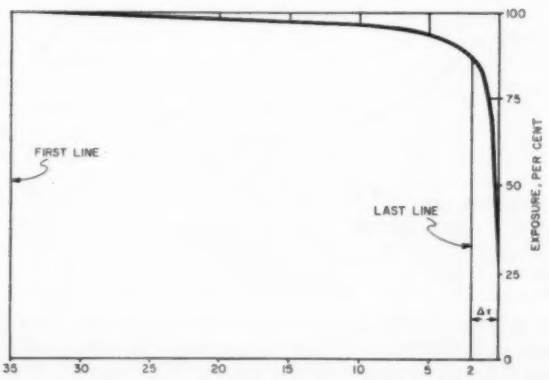

Fig. 6. Exposure percentage in relation to line position. Time scale shows integration period. Film pulldown starts at 0 msec, terminating exposure.

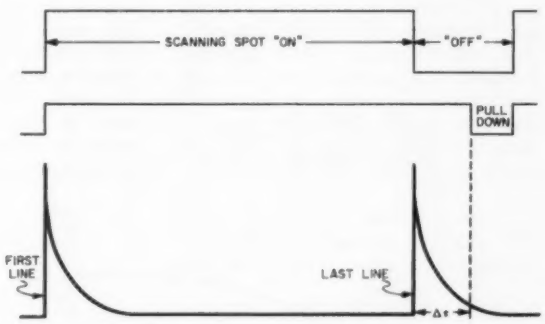

Fig. 5. Brightness plots of representative points in first and last lines, and relation to operating cycle of electronic shutter. Plot is for P11 phosphor.

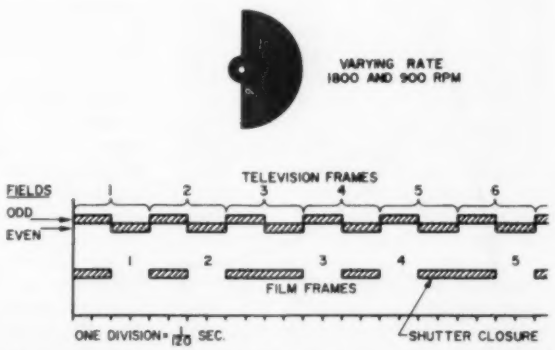

Fig. 7. Operating cycle, E. W. Daugherty Telecorder Equipment.

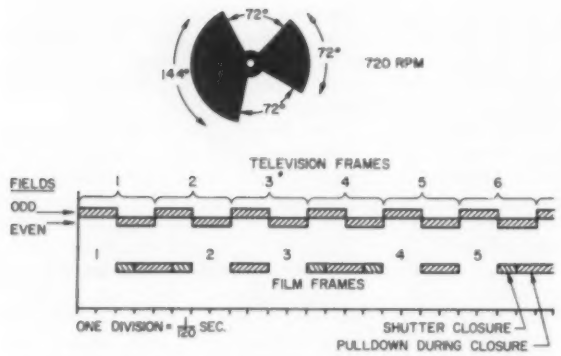

Fig. 8. Operating cycle, Dage KR11 Recorder or Television Specialties Camera.

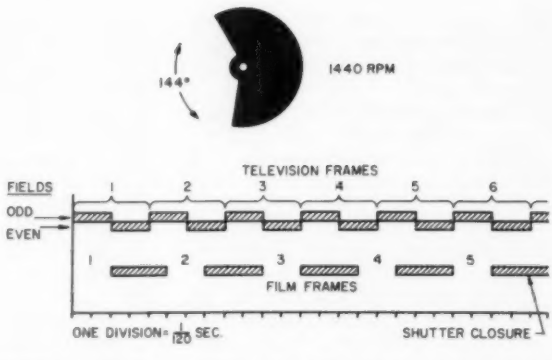

Fig. 9. Operating cycle, Bach Auricon TV-T Television Transcription Equipment.

Fig. 8, is a disc type with two unequally spaced 72° apertures. It rotates at a constant 720 rpm (12 rps) which is one-half the film frame rate. Film pulldown always occurs during a closed-shutter period. When the shutter is phased properly to the TV field, the splice region is always hidden in the vertical blanking interval. In this respect, the system behaves like the one previously described.

A third widely used mechanical shutter mechanism is the Bach Auricon TV-T.[5] This shutter is said to record one TV field per motion-picture frame, together with any afterglow remaining on the phosphor during the shutter open interval. The shutter, shown in Fig. 9, is a disc type with a single 144° aperture. Rotating at a constant 1440 rpm, the film frame rate, it is open for $\frac{1}{60}$ sec and closed for $\frac{1}{40}$ sec. When the shutter is phased properly to the TV field, as shown in the figure, the splice region of alternate fields is hidden in the vertical blanking interval and the splice region of the remaining fields falls in the center of the picture.

Rank Precision Industries, Ltd., has recently announced a "stored field" system.[6] The phosphor used has a persistence extending to 20 msec. The image of one field, scanned during the film pulldown period, remains on the phosphor during the subsequent field, when the mechanical shutter is open. Some semblance of a fully interlaced frame is therefore recorded during the interval while the shutter is open and the film is stationary in the gate. Exposure equalization is required because one field has been newly scanned while the previous field, which was scanned during the pulldown of the film, is already decaying. The profile of an accurately cut mask rotated by the camera driving shaft is viewed by a photocell to generate the required equalization waveform.

Phosphor Persistence Effects in Single-Field Recording

Having reached this point in preparing this paper, we became curious as to the shape and magnitude of the correction waveform required to provide uniform exposure for all the lines of the odd field during which the shutter is open. The information available was significantly vague on that point. We therefore went back to the characteristics of typical phosphors in an attempt to calculate this result. The answer was a bit surprising and is worth discussing.

First, it is worth reviewing the tremendous contribution which persistence emission makes to the total exposure of the film. The falling curve of Fig. 10 indicates the decay characteristic of a P4 phosphor according to available published data. The rising curve shows how the effective exposure increases as the integration period increases. Note that

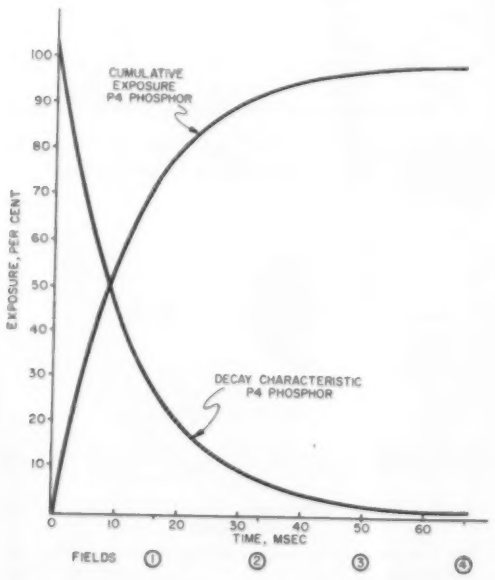

Fig. 10. Build up of film exposure with persistence illumination.

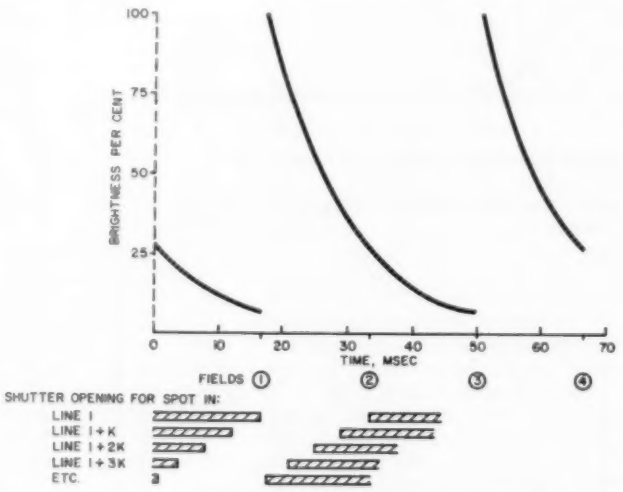

Fig. 11. Brightness pulsation cycle of a representative point due to phosphor persistence, and relation to operating cycle of single-field mechanical shutter. A series of shutter openings of progressively earlier phasing in relation to the TV frame is shown. This is equivalent to showing progressively later samples of the TV frame in relation to the shutter opening.

the total effective exposure is zero if the exposure interval is zero, despite the fact that peak brightness is then available to the film. As the period of integration becomes longer, the cumulative exposure increases for some 50 msec or more. Keeping this curve in mind will help toward understanding the following statements.

Actually, the phosphor does not decay away to zero intensity as Fig. 10 would indicate. Instead, there is a re-excitation of the phosphor every $\frac{1}{30}$ sec. The plot shown in Fig. 11 is the brightness of some representative point on the cathode-ray tube. The shutter diagram shown immediately below the brightness diagram indicates that the line containing this point was excited just as the shutter opened. The effective exposure for this particular point is then the area under the first half of the decay curve of the phosphor.

lines which occur later during the shutter open period, that is, later in the odd field. The cusp of the curve indicates the line which occurs just as the shutter closes.

The numerical values associated with this curve have no meaning; they are purely arbitrary. However, the relative values are significant and do represent the relative exposure that will be received by the film. Obviously, there is a difference which amounts to almost exactly 4 to 1.

This relative exposure range is completely inconsistent with that which we observe on film samples, with the magnitudes of correction waveforms commonly used, and with statements made anywhere that we can find in the literature. At this point it seems that either our arithmetic is pretty poor, or we have come upon something interesting.

The remainder of Fig. 12 shows the curve nor the value derived from the ascending curve. Instead, the effective exposure will be the average value represented in Fig. 13 by the straight-line curve through their intersection.

There are various opportunities for this kind of mingling of the lines to take place. First, there is simply imperfect focus of the scanning spot in the cathode-ray tube; second, there is imperfect focus of the optical image on the film; third, there is loss of interlace in the recording monitor; and finally, there is loss of resolution in the viewing system.

Having arrived at this possible explanation, we then sought confirmation in various film samples that happened to be around the laboratory. In most of these films, the exposure was quite uniform from top to bottom of the field and the focus was not very good. Just one outstanding film strip had needle-sharp focus and . . . lo and behold! . . . the

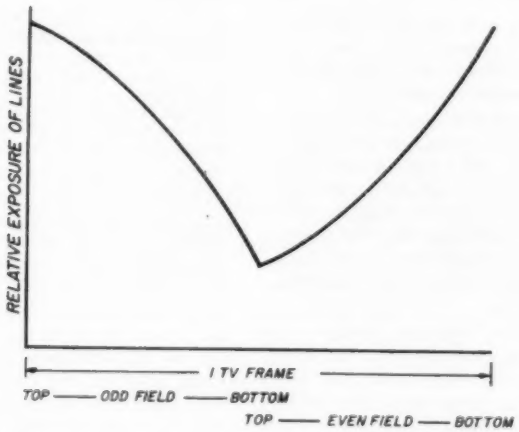

Fig. 12. Exposure contribution of each line of a TV frame in relation to the position the line occupies in the picture.

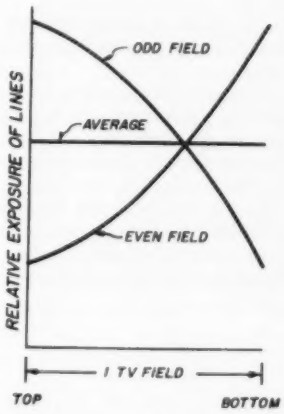

Fig. 13. Separate and averaged exposure contributions of lines in successive TV fields, in relation to position in the picture.

In order to determine relative exposure we must consider other lines which occur at different instants relative to the shutter cycle. To demonstrate a line which occurs somewhat after the shutter has opened, the brightness curve should be replotted, displaced to the right. We can achieve the same result more easily by shifting the shutter opening to the left as is shown by the succeeding shutter curves. For each new line position, the integration limits are dictated by the shutter open period. It is fairly obvious that the integrated results are not constant. Figure 12 shows the result obtained by considering all possible positions of relative line and shutter phasing. The point plotted at the extreme left represents the exposure for the line occurring exactly as the shutter opens. For the normal phasing of equipment of this type, that line is the first one at the top of the odd field. Successive points plotted to the right then indicate integrated exposure for the lines of the preceding even field, that is, the field that had occurred while the shutter was closed and which continued to glow as the shutter opened. This curve starts from the cusp which corresponds to the first line of the even field and rises to a maximum as that field progresses to the last line.

This fact — the very significant contribution made by lines of the even field — is also somewhat surprising. By combining this with our previous surprise we seem to come out with an understandable result. It must be remembered that the odd and even fields are not presented in isolation. They are in fact superimposed upon the film. If there is any step in the process at which the resolution becomes sufficiently poor for the lines of odd and even fields to tend to merge, we will then find an effective exposure which is neither the value derived from the descending results were exactly what we had predicted.

At the top of a given frame of this film there was a region of sharply focused individual lines having the spacing of single-field lines. At the bottom of the same field there was a similar region of single-field lines. Somewhere near the center of the field was a very sharply focused, very clearly resolved region having lines with full-frame spacing. Furthermore, the average density viewed by the eye seemed quite constant over the frame; but under the microscope the single-field lines showed perceptibly darker than the full-frame lines near the center of the picture.

We are now prepared to postulate that most of the single-field recording equipment in operation is not recording the odd field as has been supposed, but instead is recording a composite image made up of parts of one odd and one

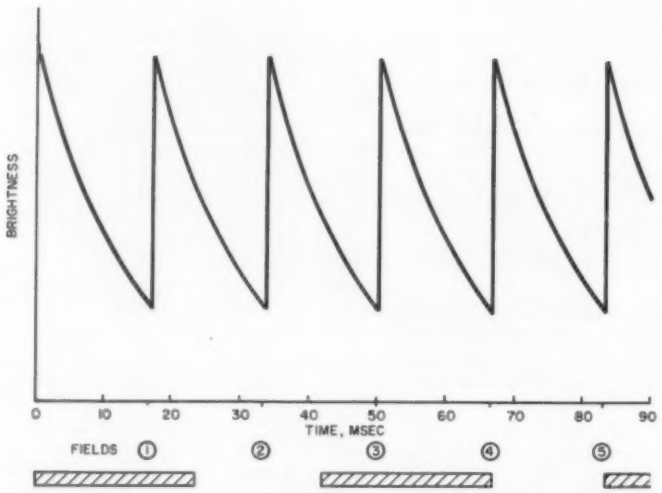

Fig. 14. Brightness pulsation cycle of a representative spot due to phosphor persistence, and relation to operating cycle of single-field mechanical shutter. Plot is for P4 phosphor.

even field. This leads to a suggestion for an optimum mode of operation of such equipment.

If one were to abandon any attempt to simulate full-frame recording with single-field equipment, he could then improve the quality of the single-field recording by completely destroying the interlace of the recording monitor. With the lines of the two fields falling upon one another, the condition would be as shown in Fig. 14. The emission curve shown here looks much the same as in Fig. 2, except that its repetition frequency has been increased from 30/sec to 60/sec. Now, when this curve is integrated over the shutter open period of $\frac{1}{60}$ sec, we find we have exactly the same case that prevailed in the full-frame mechanical shutter equipment discussed earlier. The exposure is perfectly uniform over the entire field, and the persistence of the phosphor is not a significant quantity in determining the quality of performance. The phosphor can then be selected for actinic efficiency or any other quality that may be of interest.

We arrived at these various conclusions quite recently and have not had an opportunity to check them with other manufacturers or users of single-field equipments. If there are any who have information which would add to this picture, we would be pleased to hear from them.

Acknowledgments

We wish to express our thanks to the various manufacturers cited for their kindness in making available to us descriptions of their equipment and in giving us permission to speak of them. Thanks are also due to Ralph Lovell, of the SMPTE 87th Convention Papers Committee, who, in extending the invitation to present the paper, carefully outlined the intended content of the material which became the first half of the paper.

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A Transistorized Portable Magnetic Film Recording Channel

By C. E. HITTLE, MICHAEL RETTINGER and KURT SINGER

A portable, magnetic film recording channel has been designed with a transistorized mixer and recorder, plus some accessories. The mixer provides for switching, equalizing and mixing of up to four microphones. Two independent VU meters indicate recording and magnetic playback levels. Optional accessories consist of microphone impedence matching transformers, precision gain controls and transistorized compressor. A high-gain transistorized playback amplifier and bias oscillator are located in the recorder. The recorder is manufactured by the "matched-plate" method in which the structural support for the primary rotational elements is provided by two match-bored magnesium panels to effect flywheel suspension between two bearings rather than by cantilever fashion.

THE ELECTRONICS INDUSTRY, characterized by its endeavor to manufacture an ever-increasing number of products, has seen a meteoric rise of its possibilities in today's space age. Radar, electronic computers and color television, for example, have become terms with which the public associates teams of engineers and scientists searching for new applications of electronic devices. Important as these developments are, at times it is interesting to look at the less glamorous fields, particularly to the established product lines such as radio, black-and-white television and motion-picture sound equipment. Here we are confronted with stable items that apparently do not require engineering change notices, frequent modification and constant search for new applications. This appearance is far from the truth; as new devices are discovered in our research laboratories they are soon incorporated in improved product lines. One such unit is the new Transistorized Portable Magnetic Recording Channel for Film, recently developed by RCA's West Coast Film Recording Engineering activity.

The paper is in two parts, the first covering the mechanical features of the recorder, the second describing the electronic assemblies.

Presented on May 2, 1960, at the Society's Convention at Los Angeles by C. E. Hittle (who read the paper), Michael Rettinger and Kurt Singer, Radio Corp. of America, 1560 N. Vine St., Hollywood 28.
(This paper was received on June 29, 1960.)

I. MECHANICAL CHARACTERISTICS OF THE RECORDER

Figure 1 is a front view of the PR-45 recorder. At the left is the 7.5-in. diameter supply. At the right are the take-up film reels, on which may be wound either 500 ft of standard 6-mil acetate-base film or 1000 ft 3-mil Mylar film. At the top center is the sprocket-drive mechanism; and at bottom center, the magnetic head assembly together with the two impedance drums and filter rollers. At the lower left corner of the recorder is located the Record-Off-Play switch, and at the lower right corner are the motor control switches. A film footage counter is located to the right of the sprocket drive mechanism.

Figure 2 is a rear view of the recorder. The main drive motor, at the top left of the picture, is resiliently mounted to a cast magnesium housing which contains the bias oscillator and reproduce amplifier. Behind the motor is shown the toothed belt which drives the take-up mechanism, and to the right of the motor is located the transistorized power supply for the electronic equipment. The entire lower part of the recorder is utilized for power and audio connections and adjustment controls.

Matched-Plate Method of Construction

In mechanical design, a marked difference of this recorder compared to previous units lies in the adoption of the "matched plate" method of construction.[1] Two clamped magnesium panels are machined jointly to obtain identical hole locations for all primary rotational elements. To ensure constant speed for the recording medium, most magnetic (as well as optical) recorders make use of one or two film drums coupled to a flywheel. These speed-stabilizing devices are generally supported cantilever fashion (Fig. 3, left). By using the "matched plate" design in which the flywheel is located between two bearings, as shown on the bottom of Fig. 3, the flywheel shaft deflection is much less. Referring to well-known formulas found in strength-of-materials handbooks, the equation for the maximum deflection of a beam supported at one end (Fig. 3, left) is:

$$D_1 = \frac{L^3 W}{3EI} \qquad (1)$$

when I = the moment of inertia
E = modulus of elasticity
W = load

The Equation for the maximum deflection of a beam supported at its two ends (Fig. 3, right) is:

$$D_2 = \frac{L^3 W}{48\ EI} \qquad (2)$$

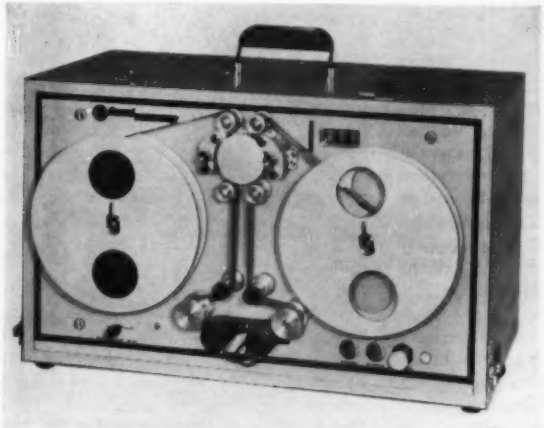

Fig. 1. Front view of PR-45 recorder.

Fig. 2. Rear view of PR-45 recorder.

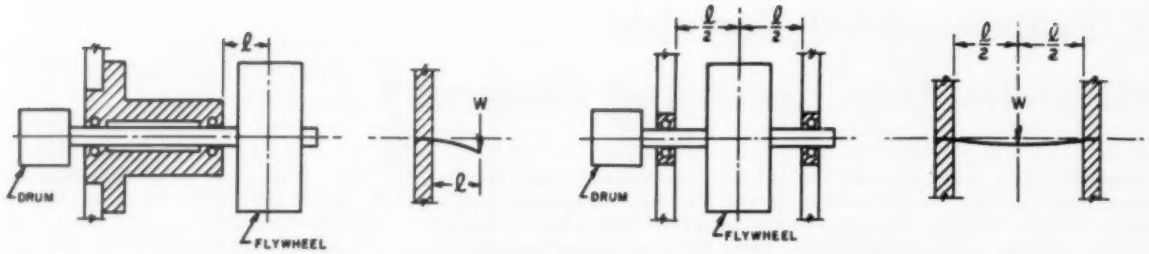

Fig. 3. (Left) Film drum coupled to flywheel supported cantilever fashion; (Right) Flywheel located between two bearings ("matched plate" method).

where W, I, and E have the same meanings as in Eq. (1). When Eq. (2) is divided by Eq. (1) it is seen that for equal L, W, I and E, the maximum deflection of the ends-supported flywheel shaft is only 1/16 that of the cantilever type. Large shaft deflections impose great radial loads on the ball bearings usually employed with such rotary members, with a consequent reduction of bearing performance.

From these considerations it becomes evident that one of the advantages of the "matched plate" method of construction lies in greater security of equipment, and hence, increased reliability of performance because the flywheel shafts are better protected against bending and accidental injury. Therefore, the flywheels need not be removed during shipping, as is sometimes recommended with other types of "portable equipment." Other advantages of the "matched plate" type of construction lie in smaller flywheel shafts and shaft bearings, which are matters of equipment weight as well as performance, and economy of construction.

Film Drive System

Figure 4 shows the electric analog of the film drive in its simplest form. A synchronous motor drives the film at a constant speed. The motor can therefore be represented by a constant (direct) current generator. In series are alternators representing the electric torque variations of the bearings through a shaft revolution, the film drive sprocket impulse irregularities, effects due to meshing defects of the mechanical elements in the gear head of the motor, uneven tension and drag of the take-up and feed mechanisms, etc. The compliance of the film between sprocket and sprung rollers is drawn larger than the compliance of the film between the heads or between the drums and the heads. This is so because the film length between sprocket and sprung rollers is considerably longer than the other film lengths. Also, the air dashpot resistance is shown much larger than the resistance of the film over the heads, because the film resistance is not a viscous, but a small solid or sliding friction. Indeed, the film-head resistance is so small that, with the magnetic heads removed, the equipment performance remains essentially unaltered, requiring merely an adjustment of the centering spring to secure correct sprung roller position; while removal of the dashpot, with the heads in place, immediately produces high amplitude oscillations of the movable system.

Removal of these minor elements therefore reduces the circuit to a simple low-pass filter whose significant elements are the inertia or flywheel-loaded drums, the compliance of the spring-tensioned film between sprocket and impedance drum, and the dashpot resistance. The fact that two "impedance drums" are used in no way changes the picture, because their combined moment of inertia is, in effect, much the same as the sum of two inductances in series. There is no need to elaborate on the constancy of film travel aided by the use of a flywheel compliantly driven by the film itself; detailed analyses have been provided by various authors in the Society's Journal.[2,3,4] While theoretically it is possible to select mechanical constants which produce a cut-off filter frequency lower than 1 cycle/sec, in practice flywheel inertias must be kept small enough and film tension high enough to permit ready starting operation. The design problem, therefore, was to select values of flywheel inertia, film loop compliance, drum wrap for film large enough to prevent film slippage, dashpot resistance, etc., for a practical unit, light enough to be termed portable and yet with a low enough flutter content to compare favorably with the larger stationary rack installations on studio lots. Thus the low-frequency flutter of the subject equipment has been kept well below 0.04%, with the total flutter content consistently less than 0.10%. It was observed that Mylar tended to reduce the high-frequency flutter content noticeably compared to the use of acetate-base film. This is due to the greater compliance of the Mylar material.

Since film compliance and resistance are not the same for different types of films and do not remain constant through film life, it is desirable to provide an ad-

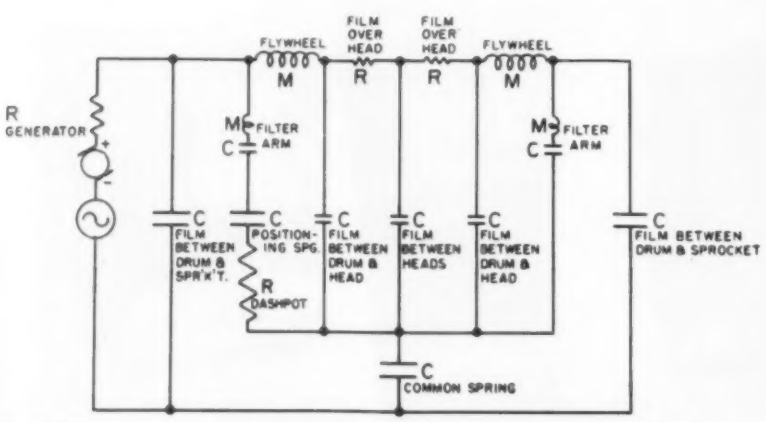

Fig. 4. Film drive electric analog of RCA PM-72 Portable Magnetic Film Recorder.

Fig. 5. Magnetic head complement for 17.5 mm recorders.

justment which will center the sprung rollers to their mean position during the operation of the recorder. This is accomplished by connecting a fine cable to one end of the arm-centering spring, while winding the other end of the cable over a friction positioned shaft. One end of the shaft has a screwdriver slot and projects through the front panel of the recorder for ready adjustment of the sprung roller position.

Versatility of Design

Since operational requirements among motion-picture studios are varied, the recorder has been designed so that with proper choice of components in assembly of the recorder, the requirements of the different motion-picture studio sound departments are readily and economically obtained. The basic recorder provides for forward operation only, using film of either 17½mm or 16mm width driven at a speed of 45 ft/min. or 36 ft/min. When desired, however, the recorder may also be modified to provide both forward and reverse operation, plus rewind. In combination with these requirements, motors can be used for operation from either a single-phase or three-phase power source.

Reel Drives

For the forward version of the recorder the take-up reel spindle is driven by an adjustable friction clutch assembly, which in turn is driven by a toothed belt from a pulley mounted on the sprocket shaft. Tensioning of the film from the pay-off reel is obtained by a single adjustable friction disc on the feed spindle. When modified to permit both forward and reverse operation of the recorder, each reel spindle is equipped with a magnetic clutch. It is powered from a small d-c power supply whose input is connected to the main drive motor power source and is on only when the motor is in operation. With both forward and reverse operation plus rewind, "takes" may be played back just as quickly as the film can be run back to the desired position. Regardless of direction of film travel, correct take-up and holdback tension on the two reel spindles are automatically obtained when the desired motor directional control switch is actuated.

Multiduty Motor Control

The multiduty motor control unit incorporates all the facilities required for centralized operational control of two camera motors and the recorder motor from either d-c or three-phase a-c power source.

On a vertical control panel are two camera motor power selector switches, d-c operation speed control rheostat, recorder motor power source selector switch, d-c voltmeter, frequency meter calibrated for frames per second speed indication, marker-switch, and d-c ammeter for indicating battery drain.

The three-phase line fuses, d-c line fuse, d-c and a-c master start switches, phase indicator light, and d-c operation speed selector switch are mounted on an horizontal panel.

Convenient access to the interior parts for servicing is provided by opening the rear panel. Relays and resistors are incorporated in the circuitry to provide soft starting of the motors when using either a-c or d-c power and also the relay for closing the market circuit to the cameras.

When in the studio, the multiduty motor control may be connected to the three-phase power supply so that both recorder and camera motors may be powered from the a-c supply and controlled from this unit. On location, batteries are connected to the unit for camera motor power; and the three-phase power for the recorder motor is obtained from the three-phase power generated in the a-c windings of the camera motors and thus affords in-phase operation of the recorder with the cameras.

Magnetic Heads

Figure 5 shows the magnetic head complement for 17.5mm recorders. The magnetic head has a 0.200-in.-wide core mounted in a cylindrical brass housing. In the case of 16mm recorders, however, a film-supporting shoe is incorporated in the head housing. The azimuth adjustment is the same for both types of magnetic heads, and is effected by loosening a clamping setscrew in the head mounting, rotating the head slightly by means of a wrench applied on the rear extrusion of the head housing, and then retightening the setscrew.

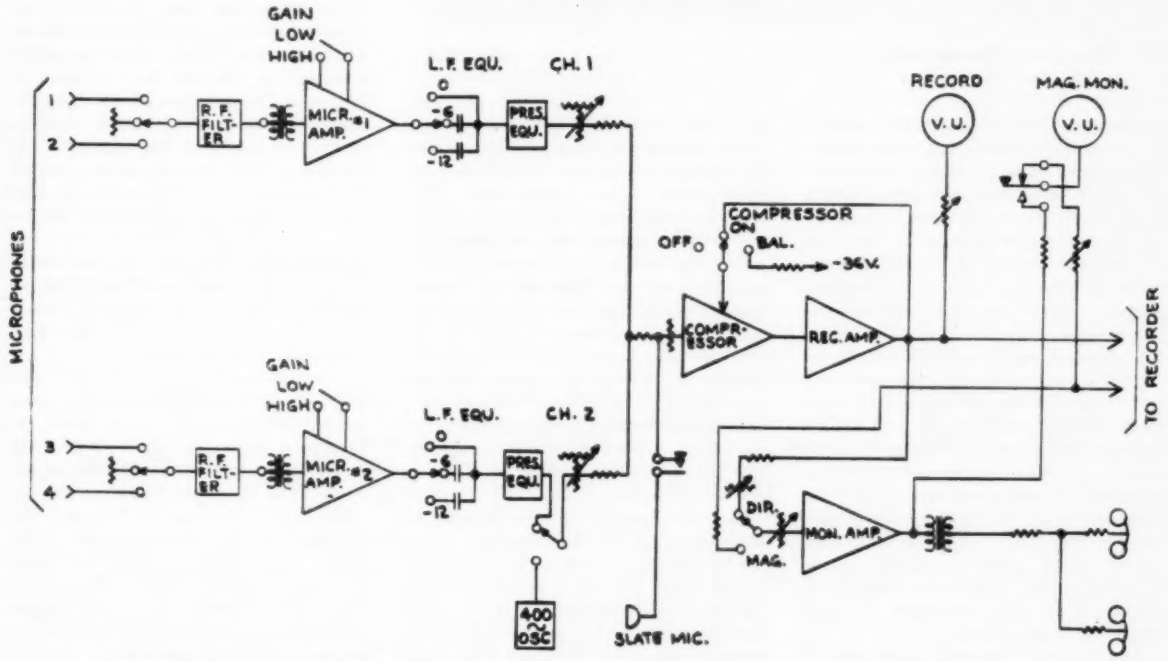

Fig. 6. Block schematic of PA-151 mixer.

II. ELECTRONIC ASSEMBLIES

The PA-151 Portable Mixer permits the combining and controlling of the outputs of two microphones. Four micro-

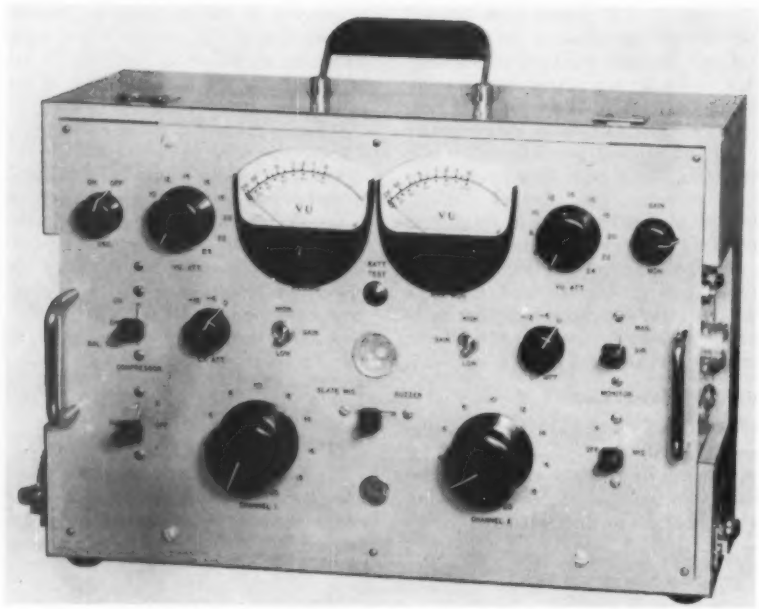

Fig. 7. Exterior view of the mixer.

phone input plugs are provided; however only two microphones can work at one time. Figure 6 is a block schematic of the mixer. The four microphone input plugs are shown at the left. Two three-position switches provide selection of two microphones or application of a resistive termination at the primary of the plug-in microphone transformers. Microphones of impedances of 150, 250 or 600 ohms are usable without transformers; however transformers are required for 30- or 50-ohm microphones, or in cases where it is desirable to work 150-or 250-ohm microphones over a balanced input line. When transformers are not required, dummy plugs are used. The components for both microphone amplifiers are mounted on a common, etched circuit board made of glass epoxy. Switches located on the mixer front panel permit 20-db gain reduction of these amplifiers when necessary.

The outputs of the microphone amplifiers are brought to adjustable, low-frequency attenuation networks (series capacitors) with zero, 6- or 12-db loss at 100 cycles. The low-frequency network controls are available on the mixer front panel. The signal then goes to two constant resistance equalizers which provide 6-db boost at 8000 cycles for presence equalization. A simple change of strapping deactivates these equalizers when desired, as for instance, for music recording.

Mixer Controls

Two mixer controls of bridged "T" configuration are used for level adjustment. Continuously variable carbon-type controls or wire-wound precision attenuators are supplied. The carbon controls have a maximum attenuation of 54 db whereas the wire-wound controls have about 80-db attenuation. The combined outputs of the mixer controls are then brought to the compressor input, if supplied, or to the input of the recording amplifier. The output of the recording amplifier goes to a 9-pin plug which provides interconnection to the recorder and power supply. One VU meter with its range attenuator indicates recording level. A second VU meter with its range attenuator measures the playback level at the output of the magnetic playback amplifier located in the recorder.

A monitor amplifier is normally bridged across the output of the recording amplifier for headset monitoring. By means of a spring return key, the monitor amplifier input can be connected across the playback amplifier output, permitting instantaneous comparison between direct and recorded sound. 600 or 50-ohm monitoring headsets or ear inserts can be used; an impedance matching transformer is required for the low-impedance units. Suitable controls allow a precise level balance between direct and magnetic monitor and between the two VU meters to facilitate comparison. The mixer contains also a microphone for recording take numbers (slating) or communication between the mixer operator and the boom man and recordist. A 400-cycle line-up oscillator occupies a portion of the monitoring amplifier etched circuit board.

Figure 7 is an exterior view of the mixer. The entire mixer has been designed, not so much for minimum size, as for operational convenience and optimum serviceability. All metal parts of the chassis are aluminum. The section carrying the amplifiers is hinged to the control panel, permitting easy access to all controls located thereon. The cover of the hinged part is removable to gain access to the amplifiers.

Amplifiers

All amplifier interconnections are soldered to avoid the possibility of noise due to poor plug connections and also to conserve space. All amplifiers are transistorized, the components and transistors are soldered to glass epoxy, etched circuit boards for maximum stability. Experience has shown that transistors, once selected and aged, have extremely good life and require a minimum of replacement, even over a period of years. It therefore has been our design philosophy to solder transistors into the circuit boards rather than to provide sockets. If trouble should develop it is far more practical and less time consuming to replace an entire mixer than to make repairs on the set, thereby holding up the director and the cast. All amplifiers incorporate large amounts of negative feedback and, where necessary, thermistors for temperature stabilization. The number of transformers has been kept to a minimum; in fact, in the standard version, the only transformer in the entire channel is the oscillator coil in the bias oscillator. In order to obtain sufficient output power, such as in the recording, monitor and playback amplifiers, class B complementary symmetry push-pull circuits are used.

The maximum overall 400-cycle gain is 107 db when using 50-ohm microphone transformers, without transformers the maximum gain is 104 db. With the compressor the gain is 115 or 112 db, respectively. The frequency characteristic exclusive of the presence equalizer is flat between 400 and 9000 cycles. A 12,000-cycle low-pass filter restricts the high-frequency response. Below 400 cycles a rising low-frequency response provides recording pre-emphasis to the extent of about 3.5 db at 100 cycles and 5 db at 60 cycles. A signal-to-noise ratio of 54 db referred to a microphone level of −70 dbm is obtained from the mixer. The power requirements for the mixer are 36 v d-c at 0.036 amp without compression or 36 v d-c at 0.047 amp with compression. The external dimensions are $17\frac{1}{4}$ by $11\frac{3}{4}$ by 7-in high. The weight is 21 lb.

The etched circuit board containing the compressor is supplied as an accessory and mounted on the amplifier tray in a space reserved for this purpose. This is the only amplifier in the channel in which transformers are used. These transformers provide isolation for the variable loss attenuator and also feed the full wave control rectifiers.

The Circuitry

Figure 8 is the circuit schematic. The combined signals derived from the mixer gain controls are applied to terminals 1 and 2, amplified by Q401 and Q402 and then attenuated by the balanced voltage divider formed by R414, 415, CR401, 402 and the primary of T402. The primary of T402 is shunted by fixed resistors R417 and R419 and potentiometer R418. The voltage appearing across the secondary of T402 is fed over terminals 3 and 4 to the input of the recording amplifier. The output of the recording amplifier is fed to the recorder, the VU meter and monitor amplifier input. However it is also fed to the control amplifier input terminals 7 and 8. The amplitude of the control signal derived from the recording amplifier output can be adjusted by potentiometer R435. R434, C417, C414 and C415 are frequency response adjusting networks whose purpose will be explained later. The control signal is then amplified by Q403, 404, 405 and 406 and rectified by a full wave control rectifier consisting of CR403 and 404. The output of these rectifiers is filtered by R416 and C407 and then brought to the slider of potentiometer R418. It is finally applied through R414, R415 as a positive bias to the anodes of silicon diodes CR401 and CR402. These diodes do not conduct as long as no positive bias or a bias of smaller positive magnitude than their inherent negative bias of 0.7 v is applied to their anodes. When a positive bias of more than 0.7 v is applied then the diode resistances decrease and they form the shunt arm of the previously mentioned balanced attenuator formed by R414, 415 and the primary of T402, thereby increasing the loss of this attenuator.

In actual operation the secondary of T402 is terminated by the input impedance of the recording amplifier. In order to eliminate any thump caused by sudden d-c level changes of the diodes and differences in their dynamic characteristics, a balancing arrangement consisting of R417, 418 and 419 has been provided. In actual field operation of the device, a d-c balancing pulse is applied to the input of the control amplifier, terminals 7 and 8. The arrangement for obtaining this pulse consists of a resistor with one side connected to the −36 v d-c supply and a spring return switch. A d-c voltage pulse is applied momentarily to the input of the control amplifier by connecting the other end of the resistor connected to the −36 v supply to terminal 7. This pulse is then amplified by Q403, 404, 405 and 406, rectified by CR403 and CR404 and then applied as a positive bias pulse to silicon diodes CR401 and 402. While applying this pulse repeatedly, potentiometer R418 is adjusted for minimum thump at the output of the recording amplifier. The balance thus obtained can be observed visually by means of the recording VU meter and aurally by means of the monitor headset.

Potentiometer R435 permits adjustment of the level at which compression begins. This level is called the breakaway point. The compression ratio is fixed at a slope of two to one due to the initially inherent bias of the silicon diodes. Since this slope is used most frequently it was felt that means for adjusting the slope, such as a fixed bias adjustment of the control rectifiers, could be omitted. With the breakaway point at +4 dbm and full compression of 10 db at +14 dbm, corresponding to 100% film modulation, this compressor provides the frequently used compression ratio of 20/10 (Fig. 9). The adjustment range also includes a compression ratio of 30/15, starting at −1 dbm with 15-db compression at +14 dbm.

Resistor R434 and capacitor C417 raise the high-frequency response of the control amplifier to obtain "de-essing." This term is used in the motion-picture industry to denote the use of increased compression at high frequencies. This is done to reduce the accentuation of sybillants of compressed speech. C414 and C415 attenuate the low-frequency response of the control amplifier in order to compensate for the low-frequency recording pre-emphasis contained in the recording amplifier. The constants of this equalizer have been selected so that, with a compression ratio of 20/10, the low-frequency pre-emphasis is retained essentially unchanged as compared to operation below breakaway level or

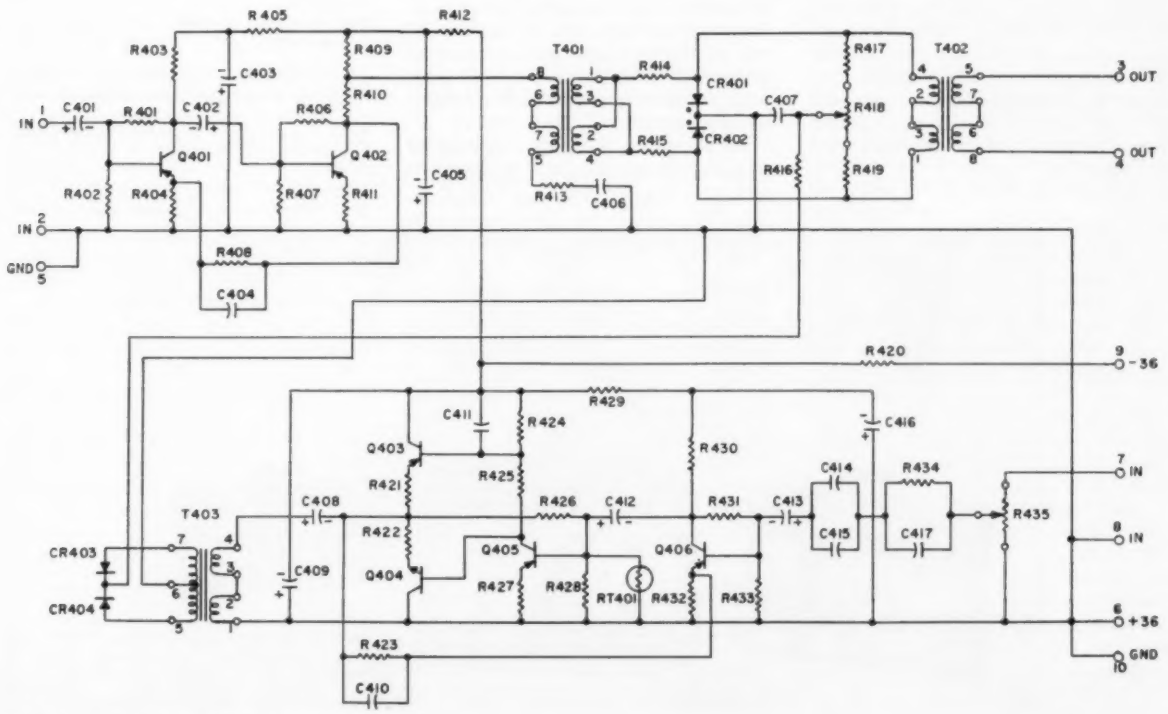

Fig. 8. Schematic of circuit of the compressor.

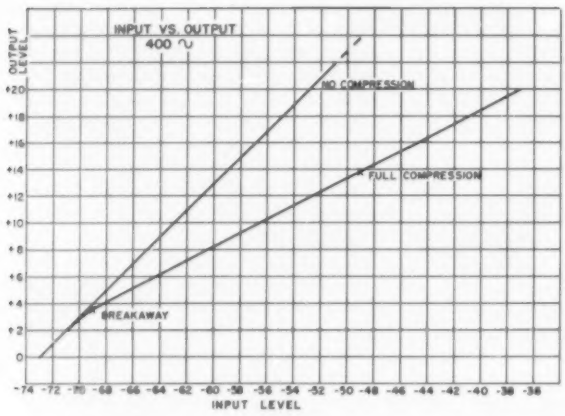

Fig. 9. Compression characteristic of MI-10180A mixer.

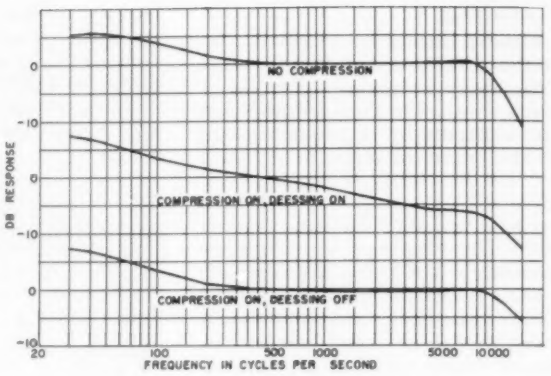

Fig. 10. Frequency response of MI-10180 mixer with and without compression.

without compression. Figure 10 shows the frequency response of the MI-10180 mixer with and without compression.

The gain of the compressor is 8 db. This approximates the 10-db gain increase which is required when one wishes to obtain 10-db compression with the same signal input to the mixer and without change of mixer controls.

The transistorized bias oscillator and playback amplifier are located in the recorder. The oscillator will deliver up to 20 ma of bias at a frequency of 70 kc with less than 0.2% distortion. The normal bias requirement is about 10 ma for the 7-mh record head. The inherent stability of the bias ocsillator makes a bias meter unnecessary. The bias adjustment control is set for maximum sensitivity bias and then left alone. High-frequency pre-emphasis of 3 db at 8,000 cycles is also contained in the bias oscillator. The setting for maximum sensitivity bias can be easily determined by means of the lineup oscillator and the playback level VU meter.

Reproduce Head

A 270-mh reproduce head feeds the playback amplifier. Its output level from 100% modulated magnetic film (1% distortion reference) is about +14 dbm. The amplifier distortion at this level is less than 0.3%. Suitable controls are provided for bias adjustment and setting of the recordist's headphone level. 600- or 50-ohm headsets or ear inserts can be used, a 600- to 50-ohm transformer is required for the low-impedance units.

Power Supply

A load and line regulated a-c power supply, also transistorized and located in the recorder, furnishes amplifier power of 36-v d-c. The average current requirement of the complete channel is about 75 ma. The power supply has a capacity of 150 ma in order to take care of peak loads occasioned by the class B operation of the transistors.

A battery box using dry cells supplies amplifier power for use in locations where no a-c lines are available. This battery box attaches to the back of the recorder case, a cable and plug forming the electrical connection. A slide switch on the recorder control panel affords selection of battery or a-c power supply.

Figure 11 shows the overall channel, from microphone to monitoring earphones. This equipment is shipped complete in one compartmentalized shipping trunk. All that is necessary for installation is to remove the various units from the trunks and to interconnect them with the necessary cables.

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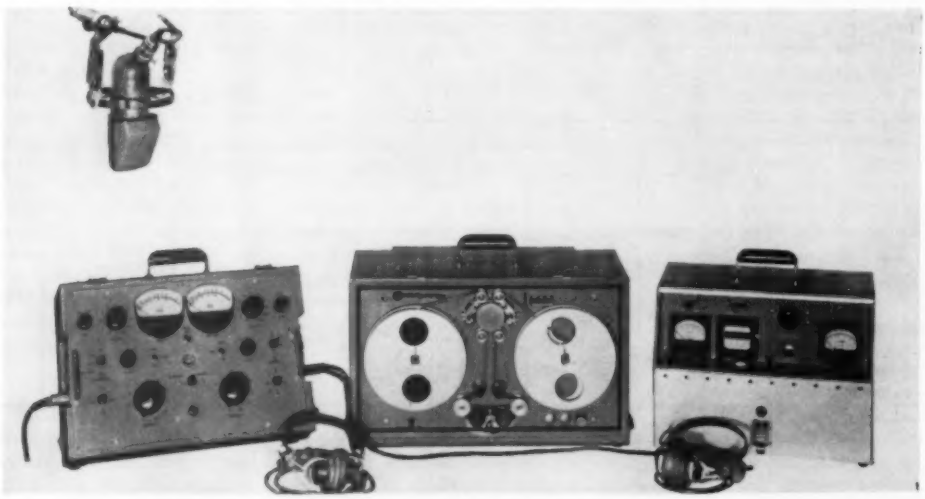

Fig. 11. Overall channel from microphone to monitoring earphones.

Internal Supervision of Industrial Films Produced Out-of-Plant

By H. L. VANDERFORD

Many industries needing too few or too many films a year for an in-plant film unit to handle, employ industrial film producers to make their training and public relations films. The film section at A.T. &T., parent company of the Bell System, engages such producers to make about seventeen films each year. This centralized production insures uniformity and economies. The production costs are shared by the 21 associated telephone companies. Creative talent is selected on the basis of proved ability and suitability rather than by competitive bid.

MOTION PICTURES have been used by the Bell System for more than 45 years. When the final splice was made in the first transcontinental telephone line in 1915, a 35mm camera documented the event. As early as 1919 animated cartoons were made by the famous Bray Studios and Max Fleischer's Out of the Inkwell Studios. Live action films were produced by J. Alexander Liggett Productions. Since then, the film activities of the Bell System have combined in-plant production with the talents and facilities of outside producers.

In the silent days (Fig. 1) and up to 1929, certain of the Bell System companies and also Western Electric each produced one or more public relations films each year. All were filmed in 35mm for theatrical as well as for 16mm distribution. A film section established at American Telephone and Telegraph Co. (AT&T) in 1925 produced several films each year on subjects of interest to most of the associated companies.

With the introduction of sound the in-plant operation was modified to the extent that while the in-plant film section was responsible for writing scripts and directing and photographing location scenes, sound camera crews and sound stage facilities were provided by industrial producers or service studio companies (Fig. 2).

The Armed services proved during World War II that the motion-picture film was a far more effective training aid than industry had believed possible. The Bell System film program which had averaged five films per year before World War II jumped to about fifteen in 1946. It was no longer practical for the film section to devote the time needed for research and script writing. Only a portion of the location photography could be done by staff cameramen. The film section, therefore, became a planning and supervisory group directing research and writing and supervising the production and distribution of films produced under contract with industrial film companies.

Main Objectives for Bell System Films

Today the main objective of the film section of the Public Relations Department of AT&T is to take whatever action may be necessary to make the motion picture available as an aid to Bell System management in meeting the problems of the business. To accomplish this, specific objectives have been defined in the areas of Production, Distribution and Evaluation.

Production: To produce films and associated material of common interest to the associated companies where uniformity is desirable and economies can be realized through centralized production; to select for the annual production program those subjects that will be most helpful in meeting the problem areas of the business; and to keep the film library up to date.

Distribution: To advise and assist associated companies in all phases of film distribution, i.e., promotion, cataloging, shipping, maintenance and reporting.

Evaluation: To continue testing in the areas that are still relatively unexplored. (We have much information to guide us in producing films of high interest that will inform or train effectively. There remains much to be done, however, in the field of attitudes with both public and employee audiences.)

The film section of twelve persons is relatively small for the seventeen or eighteen films scheduled each year. The Planning and Project Supervisors are men with ten to thirty years experience in Operating or Public Relations Departments. This background enables them to direct the research and work of the script writer with authority. During production they guard against technical errors in the portrayal of telephone employees or the operation of equipment. They are also responsible for testing and evaluation studies.

The Production Manager's group handles production and distribution, and advises the associated companies on their production and audio-visual equipment matters.

From the start of a film project, the Planning and Project Supervisory group and the Production group work as a team. During early conferences the purpose and content of the film are resolved. The value of the project is determined and the budget agreed upon. Whether this is small or large depends on the importance of the objective. The next step is to select the right script writer and producer — not always a simple task.

Selecting Creative Talent

It may be desirable to get bids for the production of a film if all the creative thinking has been done, the shooting script approved, the cast and locations set, and the film story-boarded. But this is not often feasible with industrial films, particularly public-relations productions. We do not believe you can get the best efforts from creative talent at bargain prices. Therefore, writers and producers are selected just as a casting director seeks out the best available actor for a part.

At last count there were more than 350 well-established industrial film producers in the United States. They range from divisions of major film studios to one-man companies. The film section maintains an active file of several hundred producers.

Occasionally a treatment must be written before the most effective format is clear and the selected producer called in. In such cases free-lance writers are employed. We feel very fortunate when a good producer has just the right writer on his staff and, of course, that producer is in a most favorable position.

After a writer or producer has been selected, conferences are held with the Project Supervisor and Production group during which the problems of the project are thoroughly discussed and a contract is signed for research, treatment, and shooting script. When the script has been approved, conferences with the producer resolve such details as talent, clearances, locations and other production requirements. We make our own cost estimate and if the price quoted by the producer varies widely we get together to find the cause of the variance.

Presented on May 3, 1960, at the Society's Convention in Los Angeles by H. L. Vanderford, Film Production Manager, American Telephone and Telegraph Co., 195 Broadway, New York 7, N. Y.

(This paper was received on May 16, 1960.)

Perhaps he has planned to use more extras — build a set rather than gamble on location shooting — use a blue backing technique to add realism to a scene, or estimate more shooting days than we felt were needed. If they will increase the effectiveness of the picture materially and the budget permits — all is well. If not, the production will be simplified and the price adjusted accordingly.

We are always willing to have the contract give a range price usually plus or minus 5% to take care of contingencies. If contingencies do not occur, the final payment will be adjusted to reflect this saving.

Contract Agreement

Our contract is usually in the form of a letter agreement rather than a long legal document, for several reasons; mainly because it is between companies with integrity and individuals with mutual respect, there is no need to include "act of God" clauses and small print — just the facts — specifications — type of film to be used — caliber or names of principals in the cast — what is to be delivered — clearances needed — completion dates — cost and manner of payment. If we ask for changes at a later date that materially affect cost, these are settled by mutual agreement when they come up. If we expect to have theatrical or television distribution of a film using a professional cast, especially one including high-priced talent, it is advantageous to negotiate for TV clearance at the time casting is done.

With production underway, the Production Supervisor and the Project Supervisor work closely with the producer. The Production Supervisor arranges for shooting on telephone locations, provides telephone props, and supervises set design, casting, scoring and final mix. During shooting, the Production and Project Supervisors are at hand to provide technical guidance or resolve on-the-set problems without delay.

Laboratory Work

There are many good laboratories and their price schedules are competitive. Important considerations are consistent quality, service and capacity to supply a large quantity of prints within a short time. The time element is not of paramount importance if the initial print order is under 200 reels per week, but our average requirement for initial release is 250 prints and they may be 30-minute pictures. The laboratory selection is discussed with the producer to be sure our preference is agreeable to him and his cameraman. It is, of course, unwise to have one laboratory do the developing and dailies and another to do the release printing, so the number of release prints needed will influence the choice of the laboratory.

Last October a 28-minute film on telephone courtesy for business firms was released. This film, *A Manner of Speaking*, required an initial release of 250 prints immediately followed by a reorder for 500 prints. Within 60 days from release, 750 prints had been ordered and delivered. Incidentally, initial orders for 16mm color prints of the Bell Science films — and these are 200 ft long — now run over 500 prints and the delivery schedule is 30 days.

How long does it take us to make a film? A lot depends on the planning and research time. Training films take longer. One reason is that the preparation of a script may focus attention on operating practices that need revision, and the working out of changes in these practices may take time. Also, the script for training films must be carefully checked and submitted for approval by several departments. Beginning with research, the time for release prints to reach the field averages eleven months. Production and laboratory work accounts for about five months of this time. Public-relations films average eight months, since research time is usually much shorter. In both cases laboratory time is included to prepare matrices or two internegatives, answer prints in both 35mm and 16mm, plus release prints. Of course, we have our share of short-fuse films but these are not recommended practice.

Fig. 1. Author (1929) directing Bell System public relations film on safe driving. (Bell & Howell camera).

Fig. 2. Author (1932) directing Bell System film *The Committee Reports*.

Ninety per cent of our production is in 35mm Eastman Color with all public-relations films released in both 35mm and 16mm Eastman Color or Technicolor. Employee information and training films are, with few exceptions, shot in 35mm color with release prints in 16mm color. Shooting in 35mm is, of course, a little more expensive but the advantage of being able to use scenes from training films as stock footage for future public-relations productions makes this worth while.

Theatrical Distribution

Major public-relations films intended for theatrical as well as 16mm distribution have been produced in Superscope. This system uses standard 35mm cameras with special aperture plates to use the entire width of the negative from sprocket hole to sprocket hole. This oversize frame area is squeezed in printing to produce a 35mm print for theater projection with a standard CinemaScope anamorphic lens. The projected aspect ratio becomes 2.55 to 1. The top and bottom of the original frame are masked out, but this is anticipated during shooting and headroom and foreground allowances are made. Internegatives or matrices for 16mm normal prints can easily be made by optical reduction.

For the special-type film where 35mm color is not justified due to a relatively small distribution, production in 16mm Ektachrome has been used with excellent results.

A big budget is not always necessary for the production of a good film. But when a picture is intended to be effective, to have a long life, and to be seen by millions, every effort must be made to make it as near technically perfect as possible. A good film must effectively inform, inspire or instruct its viewers without "boomerang" effects. It must immediately get and sustain high interest or lose audience attention. It must be well produced or a good portion of its audience, accustomed to the standards of television and feature films, will be distracted by amateur acting, underlighted scenes, washed-out color or poor sound. It doen't take a high budget to insure that writing, directing, photography and sound are well done. Most in-plant films meet this standard. They are made by men with pride in their work and with technical skill, but films produced under contract may fall short of these standards if the client wants too much for his money or chooses an inexperienced producer.

Testing and Distribution

Distribution of a film presents difficulties if those responsible for its use feel it is a poor job of film making, but a well-made film is a joy forever. It will be in constant demand by those who can use it as a training or public-relations aid and those who have seen it will encourage others to see it also.

Public-relations films are tested for favorable attitudes toward the company, amount of information retained by the audience, and sustained interest. In a number of instances changes have been made in films as a result of tests.

Three or four films that present information in areas difficult to explain to laymen are scheduled for tests during 1960.

The simplest type of sampling test consists of inviting a cross-section audience to a small preview theater and interviewing them in depth both before and after seeing the film. A more elaborate test uses larger audiences.

On several occasions we have made use of a filmed storyboard with a mixed soundtrack to pretest a film. The pretest spotlighted weaknesses and script changes were made before actual production began.

Distribution is too large a subject to discuss here in detail but a brief explanation may be of interest. The associated companies handle the distribution in their territories. They vary in their choice of methods but most use bookers for theatrical distribution; commercial distribution companies, for 16mm films; and some maintain their own centralized libraries. Anywhere in the United States and areas served by the Bell Telephone Company of Canada, a Bell System film can be booked by merely calling the local Bell Telephone Company business office. In areas served by independent telephone companies, arrangements can usually be made to borrow Bell System films through the independent company's offices.

Reports show that Bell System films were seen by 127,217,200 people during 1959; 16mm distribution to adult groups, clubs and organizations accounts for 7,328,000; schools and youth groups totaled 30,730,000; and the employee film audience was about 1,271,000. Of this number, 921,000 saw training films, and informational films were seen by 350,000 employees. In 1959 the theater audience totaled 40,350,000.

Television film reports for 1959, based on station reports, indicated an audience of 47,544,000. (This does not include those who saw Bell System Science films on TV.)

Theater and television audience figures for the past five years were based on estimates given us by the TV stations and the theater bookers. These were such astronomical figures that we felt it would be in the interest of accuracy to use formulas whenever actual theater-ticket count was not available or the television coverage was questionable. Formulas for theaters are:

Theater (Indoor)

$\frac{1}{3}$ of theater capacity $\times$ No. of shows

Theater (Outdoor)

Capacity (no. of cars) $\times$ $1\frac{1}{2}$ (average no. of occupants in cars) $\times$ no. of shows

To estimate the number of television viewers we use the formula:

Television

$$\frac{1}{3}\ (\text{Average no. of sets in use}) \text{ of } \frac{\text{No. of sets in area}}{\text{No. of stations seen in area}} \times 2 \text{ (viewers per set)}$$

During 1960 it is expected that about 17 films will be produced and distributed; also there will be special films produced by the Western Electric Company, the Bell Telephone Laboratories and those made primarily for the Science Series.

Western Electric plans production of two films on Alaskan Defense Communications, *Aleutian Sky Watch* and *The Land of White Alice*, and a sequel to *Tools for Telephony*. The Bell Laboratories will release three specially designed films for colleges: *Memory Devices*, *Similarities in Wave Behavior* and *Ferromagnetic Domains*.

The film section's program includes public films in the areas of science and research, defense, marketing and customer instruction; and employee films on community relations, safety, sales training and operating efficiency. While film projects are classified as public or employee on the basis of their primary audience, frequently employee films on subjects such as safety make excellent films for use with adult organizations and schools; also most public films provide good background information for employees.

This year's program includes a wide variety of titles ranging from *Home Engineering*, showing how the telephone can aid the housewife, to *The Big Bounce*, a science short for theater and television distribution, on the subject of Project Echo and the proposed use of satellites for world-wide communication. Safety films, including *Safe Driving*, *Fire Prevention*, and *Electrical Shock*, are also scheduled for release. *A Manner of Speaking*, a 28-minute film on telephone courtesy intended for business organizations, continues to be extremely popular. Since its release last October, 1150 Technicolor prints have been distributed and a French dialogue version is in production for Canadian use.

The early experience of AT&T's film section as an in-company film unit has undoubtedly served well as a guide to present relations with industrial film producers, enabling us to understand their problems and help them make us the best possible films.

Films for Machine Read-Out

By HARRY P. BRUEGGEMANN

For more than a century photographic films have been designed for the approval of the human eye. With the development of electronic computers ("machine-brains"), there has come about a new use for films in machine read-out. Therefore, films must be designed to meet the "approval" of the light-sensitive cell as well as of the human eye. In making films for these new applications, a new engineering approach is required.

THE USE OF photographic films in digital computer machine systems is relatively new; in the design of such systems an important fact that tends to be overlooked is that films are made to satisfy the human eye. For a hundred years, photographic films have been made in accordance with this concept, and all modern photographic processes, standards, tests and controls are thus oriented. Photographic scientists are studying the physiology and psychology of vision,* but there is also a need for an approach to the photographic process based more on the physical sciences.

Any contemplated pure machine system which requires large memory, small space and rapid access, but does not require rapid encoding of data is well suited to the use of photographic film as the storage medium. The area and volume data storage capability of film is enormous, and because film is two-dimensional, selective read-out of large quantities of data can be accomplished almost as rapidly as an electron beam can move. Yet most of the engineers who evaluate such film systems are trained in the purely physical sciences and are discouraged when they become aware of the physiological bias of the photographic process. Thus, in order to properly fit the photographic process into modern engineering, a basic re-evaluation is necessary.

This paper is not intended to present solutions to the problems, but merely to point them out. There is at least one committee in the SMPTE investigating the differences between the photographic definitions and the equivalent physical meanings, with clarification as the goal.

As an example of these differences, consider the definition of the term "resolution." It is expressed as the maximum number of lines that a *human eye* can distinguish crossing a distance one millimeter long on the film. This definition can do no more than give a qualitative comparison between films, and is by no means an indication of the linear data packing of which the film is capable in a pure machine system. With the optical aids usually used to determine resolution, the human eye can resolve minute density differences, while ignoring the confusing effects of film grain. It is a major accomplishment to build a machine film read-out system that can come within one order of magnitude of the human eye performance. This means that for film rated at 100 lines/mm, the machine can read only 10 to 20 lines.

Color Films

The use of color films greatly expands the data storage capability of machine systems, because the amount of information that can be stored increases exponentially with the number of colors used. For example, a particular point on black-and-white film can be either transparent or opaque, and can therefore be made to represent a binary (or two-symbol) system of counting.

On two-color film, a point can be either transparent or opaque in two colors, yielding white, red, blue and black, thus representing a four-symbol system of counting. With three-color film, the counting system is eight-symbol, and for four-color film it is sixteen-symbol, and so on. Due to the imperfections of dyes, there is a limit on the number of colors that can be used. All film dyes absorb light to some extent in all colors, so as the number of colors is increased, the point is eventually reached where this color interaction makes it impossible to distinguish transparent from opaque in any color. In two-color films there are two conditions of color interaction; in three-color film, six conditions; in four-color film, twelve conditions, etc. It can be seen that this problem increases rapidly with the number of colors, and is already serious for three-color film. Three-color films in current use are designed to minimize this effect, by various devices and compensations, to the point where it is not objectionable to the human eye. But it cannot be ignored in a machine system. Figure 1 shows the spectral characteristics of typical dyes used in a three-color film system. It can be seen that both the magenta and cyan dyes absorb some blue light. This represents two of the conditions of color interaction. Yellow and cyan dye absorption of green light and yellow and magenta absorption of red light account for the other four conditions of color interaction in three-color film.

Eastman color negative materials compensate for half of the conditions of color interaction of three-color film by using integral masking. Integral masking involves a penalty, however, since the total light transmission is reduced in each

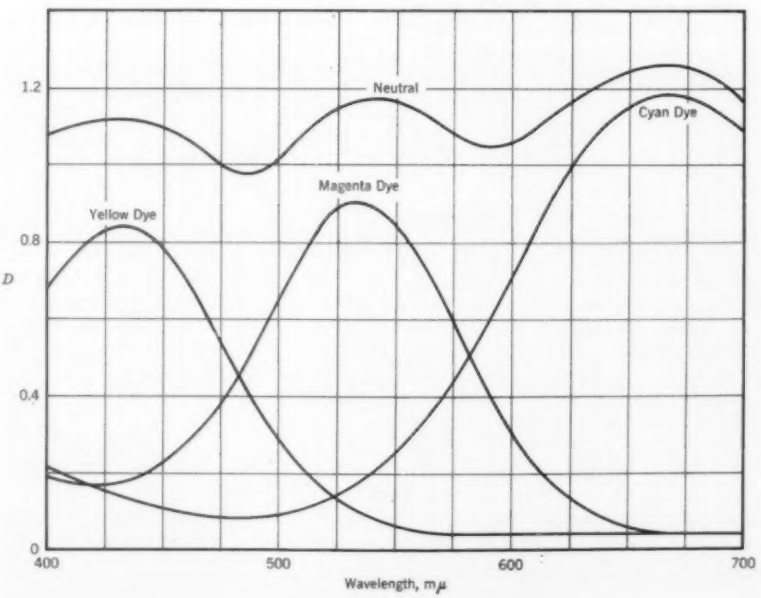

Fig. 1. Spectral characteristics of typical dyes used in a three-color film system.

Presented on May 2, 1960, at the Society's Convention in Los Angeles by Harry P. Brueggemann, Tridea Electronics, Inc., 1020 Mission St., South Pasadena, Calif.
(This paper was received on April 5, 1960.)

*Edwin H. Land, "Experiments in color vision," *Sci. Amer., 200:* 84–99, May 1959.

color by a factor of about 2½ for each condition of color interaction eliminated in that color. Thus integral masking in, say, six-color film, would gain nothing, for the film would be practically opaque even in the most transparent state. Color interaction can be minimized by spectrally spreading the dye absorption peaks apart, in other words, by using dyes in the far ultraviolet and infrared regions, with only one or possibly two dyes in the visible region. This would make the associated optics expensive, but not unreasonable.

Density

A large gap in terminology between the photographic industry and the electronics industry exists in the description of signal modulation. Photographic film modulates light by silver or dye density, and this is a logarithmic mechanism. It is logarithmic for two reasons: historically, because optical density is proportional to the logarithm of the silver deposit in the emulsion, but primarily because the optical density unit is itself a means of evaluating light as does the human eye. Also, noise in a photographic system is not absolute, but proportional to the signal level, and this enhances the need for logarithmic terminology. However, electronic mechanisms with absolute noise levels independent of signal are primarily linear devices. Areas of terminology overlap include the decibel unit in electronics, which is logarithmic, and the per cent transmission expression of film density units in photography, which is linear. In converting from one system to the other, the terminology overlap makes it important to translate noise correctly. To illustrate, consider a signal level of 3% of maximum signal. To an electronic engineer this is close to the noise level; but to a photographic engineer this is a density of 1.5, in the middle of the dynamic range.

The logarithmic aspect of photography carries the implication that absolute density measurements are not as important as measurements of density differences. This is correct. The primary control in both the manufacture and processing of photographic film is contrast. Technically, this is known as gamma, or the difference in density produced in a film for a given exposure difference. In designing machine systems it is important to keep this fact in mind, because machine systems are generally absolute systems. Thus, a machine system based on absolute density measurement of film will be harder to control than one based on measurement of density differences.

Grain Noise

The limit to which photographic film can be magnified is determined by two factors, resolution and grain. In modern film, these factors are designed to be balanced, that is, each exerts about the same limit on magnification as far as the human eye is concerned. This balance is not necessarily retained in a pure machine system. If a machine reads film by a small point of light at the film plane, the minimum diameter of this point is to a large extent determined by grain size.

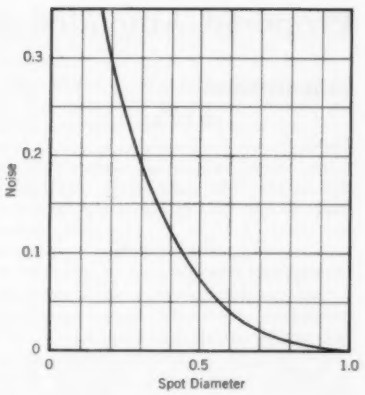

Fig. 2. Typical curve: noise vs. read-out spot diameter.

As the read-out spot is made smaller and smaller, the grain introduces a larger and larger error in the signal level. Eventually it becomes impossible to distinguish opaque film from transparent film unless the signal is averaged over a sufficiently long period of time. Figure 2 is a typical curve showing the relationship between grain noise and read-out spot diameter.

Conclusion

These are the most important problems encountered in building film-machine devices. With the clarification of these areas will come a greater understanding between the photographic industry and the electronics industry, which in turn will lead to a new field of utilization of photographic film.

Proposed Constitution and Bylaws Amendments

To All Voting Members of the Society of Motion Picture and Television Engineers

For consideration at the Annual Meeting, October 17, 1960.

Some time ago, we were advised by our legal counsel that certain refinements in the Society's Constitution and Bylaws should be made for the purpose of having them more clearly reflect the fundamental character of the SMPTE as a scientific society. The amended Constitution and Bylaws submitted herewith have been prepared by our legal counsel, the law firm of Donovan Leisure Newton and Irvine, in order to accomplish this purpose.

Certain minor changes have been incorporated into these amendments, all of which have been recommended by the Committee for Revision of the Constitution, Bylaws and Administrative Practices. Except for these minor revisions, the amended Constitution and Bylaws have been written to embody no changes in meaning or scope as compared with the present Constitution and Bylaws, last published in the *Journal*, Part II, April 1960.

It is the aim of the Society to request adoption of these amended Bylaws at the Annual Meeting scheduled for October 17, 1960. It is the further aim of the Society to request adoption of this amended Constitution by a mail ballot which will be sent to all voting members of the Society late in October or early November 1960.

August 1960 — Wilton R. Holm, *Secretary*

Proposed Amended SMPTE Constitution and Bylaws

Constitution

ARTICLE I

Name

The name of this association shall be SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS.

ARTICLE II

Objects and Powers

The purposes for which the Society was founded, and for which it has been operated, shall continue to be as follows:

1. To foster, carry on and advance the engineering and technical aspects of the motion-picture, television and allied arts and sciences;

2. To gather, receive, prepare and disseminate scientific information concerning the motion-picture, television and allied arts sciences;

3. To provide for and to encourage the delivery and holding of lectures, exhibitions, classes and conferences calculated to advance the theory and practice of engineering involved in the motion-picture, television and allied arts and sciences;

4. To promote and further the interests of the general public in the engineering, technical and safety aspects connected with the use and enjoyment of the benefits provided by the motion-picture, television and allied arts and sciences;

5. To advance the scientific aims and purposes of Subdivisions to the extent that such scientific aims are consistent with or conform to the scientific purposes of the Society;

6. To do everything and anything reasonably or lawfully necessary, proper or advisable for the attainment of the above purposes or for any of them or for the furtherance of any or all such purposes;

7. The Society, in order to foster its scientific purposes as herein provided, shall have the power to own, acquire, purchase, accept gifts, hold as trustee or otherwise, maintain, improve, mortgage, sell, lease or dispose of real and personal property and to obtain, invest, reinvest and use funds and properties of any kind to advance the scientific aims of the Society;

8. To accept in the name of the Society or hold as trustee or otherwise any gift of money or property or the income thereof for one or more limited purposes within the scope of the general purposes of the Society as stated herein;

9. To have all powers of any corporation organized for scientific purposes under the laws of the District of Columbia to the extent not inconsistent with the purposes and powers of the Society as herein provided.

ARTICLE III

Restrictions

The Society shall have no capital stock. No part of the income or property of the Society shall inure to the private benefit of any of its members, officers or any private shareholder or individual; no substantial part of the activities of the Society shall be the carrying on of propaganda or otherwise attempting to influence legislation, and the Society shall not participate in or interfere in any political campaign on behalf of any candidate for public office.

ARTICLE IV

Disposition of Assets and Dissolution

Upon the liquidation, winding up or dissolution of the Society, whether voluntary or involuntary, and after payment of all indebtedness of the Society, the funds, investments and other assets of the Society shall be given and transferred, as the Board of Governors may determine, to some other nonprofit organization having objects similar to those of the Society. The selection of such other organization shall be made by majority vote of all members of the Board of Governors at a meeting of said Board of Governors called for the purpose of selecting such an organization.

ARTICLE V

Meetings

Sec. 1. Regular Meeting. There shall be an annual meeting of the Society held at such time and place as may be fixed by the Board of Governors, and other meetings of the Society shall be called as provided in the Bylaws.

Sec. 2. Substitute for Annual Meeting. Whenever the Board of Governors, by a majority vote of all of its members, at either a meeting or by letter ballot, shall declare that by reason of any rule, regulation, request or order of any governmental agency, or for any cause, it is not in the interest of the Society to hold the annual meeting then no such meeting shall be required to be held under this Constitution and these Bylaws, and the Board of Governors shall fix a date by which the members of the Society shall vote by letter ballot on any matters which might be acted upon by the members at the annual meeting. The voting period for such letter ballot shall be thirty days ending on the date fixed as above for voting by letter ballot, and the date upon which the voting period expires shall be deemed to be the date of the annual meeting within the meaning of this Constitution and Bylaws.

ARTICLE VI

Membership

Sec. 1. Eligibility for Membership. Any individual, firm or corporation, qualified in the manner prescribed in the Bylaws, shall be eligible for membership in the Society, and shall be admitted to membership under such terms and conditions as may be prescribed in the Bylaws.

Sec. 2. Rights and Privileges. All members shall exercise and enjoy such rights as the Constitution and Bylaws of the Association may from time to time prescribe.

Sec. 3. Dues. Members shall pay such dues and assessments as the Constitution and Bylaws may prescribe.

ARTICLE VII

Board of Governors

Sec. 1. Management. The management of the Society shall be vested in the Board of Governors elected in the manner prescribed in the Bylaws.

Sec. 2. Committees. The Board of Governors shall appoint such committees as may be prescribed in the Bylaws and may appoint such additional committees as it may determine; all such committees shall act under the direction of the Board of Governors and perform such duties and exercise such powers as are specified in the Bylaws and such duties and powers as may be delegated to such committees by the Board of Governors.

ARTICLE VIII

Officers

The officers of the Society shall be a President, not more than 6 Vice-Presidents, a Treasurer and a Secretary who shall be elected and have such duties as the Bylaws may from time to time prescribe.

ARTICE IX

Subdivisions

Sec. 1. Formation. The Board of Governors may authorize the formation of Subdivisions in the manner prescribed in the Bylaws, and may combine, divide or discontinue Subdivisions at its discretion.

Sec. 2. Activities. The activities of Subdivisions shall be subject to such limitations and regulations as may be prescribed in the Bylaws, by the Board of Governors or by resolution adopted at any meeting of the Society.

ARTICLE X

Amendments

Sec. 1. Procedure and Required Vote. Amendments may be submitted to the Board of Governors by a member of the Board or may be proposed to the Board of Governors by any ten members of a voting grade. All amendments, before they are submitted to the membership for discussion and vote, shall first have been approved by the Board of Governors by resolution adopted by the votes of a majority of the whole membership thereof. The proposed amendment shall be submitted for discussion at the next meeting of the Society following approval of the amendment by the Board of Governors. The proposed amendment, together with a summary of the discussion thereon, shall be promptly submitted by mail to all members qualified to vote, as set forth in the Bylaws. Voting shall be by letter ballot mailed with the proposed amendment and summary of the discussion to the voting membership. In order to be counted, return ballots must be received within sixty (60) days of the mailing-out date. Such amendment shall become effective if at least one-fifteenth of the duly qualified members shall have voted thereon within the time limit specified herein and if at least two-thirds of the members so voting have voted to adopt the amendment.

Sec. 2. Restrictions. No amendment shall be made which shall be contrary to the carrying out of the scientific purposes for which the Society was organized, and all rights conferred herein upon any member of the Society are granted subject to this reservation.

Bylaws

ARTICLE I

Membership

Sec. 1. Membership Grades. The membership of the Society shall consist of the following grades: Honorary, Sustaining, Fellow, Active, Associate and Student.

Sec. 2. Qualifications. Individuals, firms and corporations qualified in the manner hereinafter prescribed are eligible for membership.

Subsec. A. Honorary: An individual who has performed eminent service in the advancement of engineering in motion pictures, television or in the allied arts and sciences, and who has been elected to membership as hereinafter provided.

Subsec. B. Sustaining: An individual, firm or corporation subscribing substantially to the financial support of the Society.

Subsec. C. Fellow: An individual who is not less than 30 years old and who has by his proficiency and contributions, attained an outstanding rank among engineers or executives in the motion-picture, television or related industries.

Subsec. D. Active: An individual who is not less than 25 years of age who meets the qualifications set forth in one of the following paragraphs:

Paragraph 1. An engineer or scientist engaged in the motion-picture, television or allied arts and sciences who has performed, or been responsible for, important engineering or scientific work therein for a period of at least three years; or

Paragraph 2. A teacher in a school of recognized standing who has conducted for at least three years a major course principally concerned with motion-picture or television engineering or a subject involving the related arts and sciences; or

Paragraph 3. An individual who has made a distinct contribution to the advancement of engineering or science in motion-picture, television or the allied arts and sciences, or has contributed to the technical literature thereof, or has made significant inventions therein; or

Paragraph 4. An individual who for at least three years has had, under his executive direction, important engineering and responsible work in the motion-picture, television or related sciences, and who is otherwise qualified for the direct supervision of the technical and scientific features of such work.

Subsec. E. Associate: An individual who is not less than eighteen years of age who is interested in the study of the technical and engineering aspects of the motion-picture, television, or related arts and sciences.

Subsec. F. Student: Any individual registered for at least a half-time program as a student, graduate or undergraduate, in a college, university or other recognized educational institution, who evidences interest in the study of the technology involved in the motion-picture, television or related arts and sciences.

Sec. 3. Application for Membership. Application for membership in grades other than Honorary and Fellow shall be made on forms provided for that purpose. Applicants for membership in Active, Associate or Student grades shall state the name of the person whose reference is required by the following:

Subsec. A. Active: An applicant for membership in this grade shall give as a reference at least one Active, Fellow or Honorary member of the Society.

Subsec. B. Associate: An applicant for membership in this grade shall give as a reference at least one member of the Society or two nonmembers who are actively engaged in the motion-picture, television or related arts and sciences.

Subsec. C. Student: An applicant for membership in this grade must be sponsored by a member of the Society, or by a member of the faculty of the educational institution which he is attending. It is not required that the faculty member referred to in the preceding sentence be a member of the Society.

Sec. 4. Election to Membership.

Subsec. A. Honorary. Honorary membership shall be granted to individuals qualified in the manner prescribed in Subsec. A of Sec. 2 hereof upon recommendation of the Honorary Membership Committee when that Committee's recommendation is concurred in by the affirmative vote of three-fourths of the members of the Board of Governors present at any meeting of the Board.

Subsec. B. Fellow. Active members qualified in the manner prescribed in Subsec. B of Sec. 2 hereof shall be admitted to membership in this grade upon recommendation of the Fellow Membership Committee when that recommendation is concurred in by the affirmative vote of three-fourths of the members of the Board of Governors present at any regularly constituted meeting of the Board.

Subsec. C. Active. Upon determination by the appropriate Regional Admissions Committee that an applicant meets the qualifications set forth in Subsec. D of Sec. 2 hereof and upon approval of his application, the applicant shall become a member of the Society. Any application upon which a Regional Admissions Committee takes adverse action shall be referred by it to the National Admissions Committee together with the reasons for such action. Adverse determinations shall be reversed and the applicant admitted to membership, upon a finding by the affirmative vote of four-fifths of the members of the National Admissions Committee that the applicant meets the qualifications set forth in Subsec. D of Sec. 2 of this Article. Adverse determinations by the National Admissions Committee may be appealed to the Board of Governors by the applicant or his sponsor, and such determinations shall be reversed upon a finding by the Board that the applicant meets the qualifications required by Subsec. D of Sec. 2 of this Article.

Subsec. D. Associate. Upon determination by the appropriate Regional Admissions Committee or by the Chairman thereof that an applicant meets the qualifications set forth in Subsec. E of Sec. 2 of this Article and upon approval of his application, the applicant shall become a member of the Society.

Subsec. E. Student. Upon determination by the appropriate Regional Admissions Committee or by the Chairman thereof that an applicant meets the qualifications set forth in Subsec. E of Sec. 2 of this Article and upon approval of his application, the applicant shall become a member of the Society.

Sec. 5. Voting Rights. Each member of the Society in the Honorary, Fellow, or Active grades shall be entitled to one vote on any matter presented the membership, and such members are eligible to be elected to office in the Society. Members of the Society in the Associate, Student or Sustaining grades are not entitled to vote on any matter presented to the membership, are ineligible to hold office in the Society, and may not be appointed as Chairman of any Committee of the Society. However, Associate and Student members may be appointed to serve as members of committees in which case they shall be entitled to vote on matters considered by the Committee.

Sec. 6. Termination of Membership.

Subsec. A. Resignation. Resignations of members shall be made in writing and shall be acted upon within 30 days of receipt of said resignation.

Subsec. B. Expulsion and Reinstatement. Any member may be expelled for failure to pay dues or for other just cause. If charges other than nonpayment of dues are preferred, expulsion may take place only upon the vote of a majority of the entire membership of the Board of Governors after an opportunity to be heard before the Board shall have been granted such member. No accusing or accused member shall be entitled to vote on the question of any such expulsion. Any former member whose membership has been terminated pursuant to this Subsection for cause other than nonpayment of dues, may be reinstated upon application made to the Board, and upon approval by the vote of a majority of the entire membership of the Board of Governors.

ARTICLE II

Meetings of the Society

Sec. 1. Annual Meeting. The annual meeting of the Society shall be held at such time and place as may be fixed by the Board of Governors. Other meetings of the Society may be called at any time by the President and shall be called by the President upon the written request of at least three members of the Board of Governors.

Sec. 2. Notice of Meeting. Notice of the time, place and business to be conducted at the Annual Meeting of the Society shall be mailed by the Executive Secretary to each member of the Society at his last known address appearing on the books of the Society. The notice of the Annual Meeting shall be mailed at least thirty days prior to the meeting. The time and contents of notices of other meetings shall be as directed by the Board of Governors.

Sec. 3. Quorum. One-fifteenth of the members of the Society entitled to vote on matters presented to the membership shall constitute a quorum at all meetings of the Society, but a lesser number may adjourn without notice other than announcement of the meeting. At any adjourned meeting at which a quorum shall be present, any business may be transacted which might have been transacted at the meeting as originally called.

ARTICLE III

Board of Governors

Sec. 1. Number. The Board of Governors shall consist of: (1) the elected officers; (2) the Past-President of the Society; (3) not more than twelve individuals who shall be members of the Society in either Honorary, Fellow or Active grades each of whom shall be elected for a term of two years in the manner hereinafter prescribed; (4) the Chairman of each Section containing 14% of the total membership of the Society; and (5) not more than five individuals who shall be members of the Society in either Honorary, Fellow or Active grade, elected for a term of one year by the Board.

Sec. 2. Nominations. At least four months before each Annual Meeting of the Society, the President shall appoint a Nominating Committee to nominate not more than three individuals for election to each office of the Society and not more than three individuals for each vacancy to be filled on the Board of Governors. Individuals nominated for the Board and for offices must be members of the Society in either Honorary, Fellow or Active grade. The President shall designate one of the members of the Committee as Chairman. The members of the Nominating Committee shall be two former Presidents, at least seven voting members of the Society, at least two, and not more than three of whom, shall be members of the Board of Governors.

Sec. 3. Approval of Nominations. At least sixty days before the Annual Meeting the list of nominees proposed by the Nominating Committee shall be reviewed by the Board of Governors, and said list shall be final unless the Board shall, by a three-fourths vote of those present, direct that any individual's name be deleted therefrom. It shall be the duty of the Secretary to notify the individuals appearing on said list of their nomination, and each such person shall notify the Secretary within two weeks thereafter whether he will serve if elected. The names of all such persons who indicate their assent shall then be placed upon a letter ballot prepared by the Secretary.

Sec. 4. Election. Not less than forty days prior to the Annual Meeting the Secretary shall mail the letter ballot to each voting member of the Society at his last known address appearing on the books of the Society. On the space provided on the ballot each member who wishes to vote shall indicate the individual and the position to which he wishes to have such individual elected. No individual may cast more than one vote for any one candidate, and the ballots which have been returned to the Secretary seven days before the Annual Meeting shall be delivered by the Secretary to the Committee of Tellers appointed by the President. Said Committee shall tabulate the votes not later than the first day of the Annual Meeting. Election of candidates shall be by plurality vote, and in the case of tie the choice shall be decided by lot. The names of the individuals elected shall be announced at the Annual Meeting, and they shall take office as of January 1 of the year following the date of the meeting.

Sec. 5. Filling of Vacancies. Whenever a vacancy shall occur in the Board of Governors or in any office of the Society other than that of the President, the remaining Governors may, by the affirmative vote of a majority of them, elect an individual to fill such vacancy. Individuals so elected shall serve for the unexpired term of their respective predecessors.

Sec. 6. Meetings and Quorum. The Board of Governors shall hold at least four meetings each year, one of which shall be at the time and place of the Annual Meeting of the Society. At least two weeks' notice of the time and place of all regular meetings shall be sent to the members of the Board. Special meetings may be called at any time by the President or by any two Vice-Presidents upon at least seven days' notice. At each meeting of the Board of Governors, eleven members shall constitute a quorum.

ARTICLE IV

Officers

Sec. 1. President.

Subsec. A. Function. The President shall preside at all meetings of the Society, the Board of Governors, and, if residing in the geographical area located East of the Mississippi River, at all meetings of the Executive Committee. Subject to the direction of the Board of Governors, he shall be the executive head of the Society.

Subsec. B. Substitute. During any period of absence or temporary incapacity of the President, the Executive Vice-President shall perform and have the duties and powers of the President.

Sec. 2. Executive Vice-President.

Subsec. A. Residence. The Executive Vice-President and the President may not reside in the same geographical area of the United States, unless after both are duly elected, one or the other should be required to move his residence to the same region in which the other resides. In this event neither officer shall be deprived of office pursuant to this Subsection.

Subsec. B. Duties. In the absence of the President due to death, resignation or incapacity the Executive Vice-President shall perform and have the duties and powers of the President. The Executive Vice-President shall preside at all meetings of the Executive Committee when the President does not reside in the geographical area in which the Society's principal office is located. In addition, the Executive Vice-President shall perform such other duties as may be assigned him by the President.

Sec. 3. Engineering Vice-President. The Engineering Vice-President shall be responsible for the supervision and coordination of the work of all technical committees of the Society, and, when authorized to do so by the Board of Governors, may appoint committees, define their scope, and designate the members thereof.

Sec. 4. Financial Vice-President. The Financial Vice-President shall be responsible for the financial operations of the Society to ensure that they conform to the budget submitted by him and approved by the Board of Governors. He shall keep all funds in the name of the Society in a bank, or banks, approved by the Board of Governors. He may invest the surplus funds of the Society in such manner as may be approved by the Board of Governors. At the end of each fiscal year his books shall be audited by a certified public accountant selected by the Board of Governors, and a report of such audit shall be made to the Board of Governors which shall mail it to each member of the Society.

Sec. 5. Treasurer. The Treasurer shall have custody of the funds and assets, except invested surplus, of the Society, and shall keep proper books of account. He shall disburse the funds of the Association under the direction of the Financial Vice-President and the Board of Governors. He shall give a surety company bond for the faithful performance of his duties in such amount as may be required by the Board of Governors. The premium on such bond shall be paid by the Society.

Sec. 6. Editorial Vice-President. The Editorial Vice-President shall be responsible for the content and publication of a technical magazine which shall be published twelve times each year by the Society. He shall be responsible to have a copy of each such issue mailed to every member of the Society in good standing.

Sec. 7. Convention Vice-President. Subject to the approval of the Board of Governors, the Convention Vice-President shall be responsible for the national conventions of the Society.

Sec. 8. Sections Vice-President. The Sections Vice-President shall be responsible for the coordination and administration of Subdivisions to ensure that their activities conform to the purposes set forth in Article II of the Constitution, and shall aid and assist Subdivisions by interpreting the Society's policy. He shall be responsible for aiding and furthering the formation of new Subdivisions. He shall appoint the Chairman of the National Admissions Committee, and shall be responsible for the supervision and coordination of the activities of the various other Admissions Committees.

Sec. 9. Secretary. The Secretary shall keep a record of all meetings of the Society, the Board of Governors and the Executive Committee. The Secretary shall be responsible for the maintenance of a membership roster. The Secretary shall have the custody of the records of the Society and the corporate seal. The Secretary shall perform such other duties as may be required by these Bylaws or specified by the Board of Governors.

ARTICLE V

Committees

Sec. 1. General.

Subsec. A. Appointment. Such standing and ad hoc committees as may be necessary or convenient for the proper conduct of the affairs of the Society may be appointed as provided by the Constitution, Bylaws and Administrative Practices of the Society. The chairmen of all such committees shall be voting members of the Society.

Subsec. B. Term. The members of all standing committees shall hold office until December 31 of the year following appointment or until their successors are appointed.

Subsec. C. Term of Office of Chairman. No person shall hold the office of Chairman of a standing committee for more than two

consecutive terms, but may be reappointed if there has been a lapse of one year between the date of his retirement and his subsequent appointment.

Subsec. D. Quorum. A majority of the members of a committee shall constitute a quorum unless otherwise specified in these Bylaws.

Subsec. E. Voting. No member of a standing committee may vote by proxy. Where alternates have been appointed, an alternate may vote in the absence of the Committee member for whom he has been designated as an alternate.

Sec. 2. Standing Committees.

Subsec. A. Executive Committee. The members of the Executive Committee shall be either the President or Executive Vice-President of the Society, whichever resides in the geographical area in which the Society's principal office is located, and three other officers selected by the President and approved by the Board of Governors. Subject to direction by the Board of Governors, the committee shall have all the powers of the Board of Governors to transact business between meetings of the Board and shall have such other powers and duties as may be delegated to it by the Board. All transactions of this Committee shall be fully reported at the next scheduled meeting of the Board of Governors.

Subsec. B. Honorary Membership Committee. The President shall appoint five individuals to this Committee who shall be members of the Society in either Honorary, Fellow or Active grades. The Committee may recommend persons to the Board of Governors for election to membership in the Honorary grade.

Subsec. C. Fellow Membership Committee. The membership of this Committee shall consist of the elected officers of the Society, the Past-President, the Chairman of each Section, and the Chairmen of engineering committees of the Society. The Past-President shall serve as Chairman of the Committee, or, if unavailable, the President shall appoint a Chairman from among the members of the Committee. The Committee may recommend persons to the Board of Governors for election to membership in the Fellow grade.

Subsec. D. National Admissions Committee. The members of this Committee shall be the Chairmen of each of the Regional Admissions Committees, and a National Admissions Committee Chairman appointed by the Sections Vice-President. The Committee shall make such determinations as may be required under these Bylaws and shall review the activities of Regional Admissions Committees to ensure that the activities of such committees conform to the Constitution, Bylaws and policies of the Society.

Subsec. E. Regional Admissions Committees. There shall be an Admissions Committee for each of the following four regions: Western, Central, Eastern and International. The territorial jurisdiction of each such committee shall be as defined by the Board of Governors. Each Regional Admissions Committee shall consist of a chairman and three other members of the Society in either Active, Fellow or Honorary grades. The members and Chairmen of such Committees shall be appointed by the Chairman of the National Admissions Committee with the concurrence of the Sections Vice-President. It shall be the duty of Regional Admissions Committees to process and consider applications for membership as specified by the Constitution and Bylaws.

ARTICLE VI

Administrative Practices

Sec. 1. Special rules relating to the administration of the Society and known as Administrative Practices shall be established by the Board of Governors and shall be added to or revised as necessary to the efficient pursuit of the Society's objectives.

ARTICLES VII

Dues and Indebtedness

Sec. 1. The annual dues shall be eighteen dollars ($18) for Fellows and Active members, twelve dollars ($12) for Associate members, payable on or before January 1 of each year, and five dollars ($5) for Student members, payable on or before October 1 of each year. Current or first year's dues for new members in any calendar year shall be at the full annual rate for those notified of election to membership on or before June 30; one half the annual rate for those notified of election to membership in the Society on or after July 1.

Section 2.

Subsec. A. Transfer of membership to a higher grade may be made at any time subject to the requirements for initial membership in the higher grade. If the transfer is made on or before June 30, the annual dues of the higher grade are required. If the transfer is made on or after July 1, and the member's dues for the full year have been paid, one half of the annual dues of the higher grade is payable less one half the annual dues of the lower grade.

Subsec. B. No credit shall be given for annual dues in a membership transfer from a higher to lower grade, and such transfers shall take place on January 1 of each year.

Sec. 3. Annual dues shall be paid in advance.

Sec. 4. Failure to pay dues may be considered just cause for suspension.

ARTICLE VIII

Publications

Sec. 1. The Society shall publish a technical magazine to consist of twelve monthly issues. The editorial policy of the *Journal* shall be based upon the provisions of the Constitution and a copy of each issue shall be supplied to each member in good standing mailed to his last address of record. Copies may be made available for sale at a price approved by the Board of Governors.

ARTICLE IX

Local Sections

Sec. 1. Sections of the Society may be authorized in any locality where the voting membership exceeds twenty. The geographic boundaries of each Section shall be determined by the Board of Governors. Upon written petition for the authorization of a Section of the Society, signed by twenty or more voting members, the Board of Governors may grant such authorization.

Sec. 2. Section Membership.

Subsec. A. All members of the Society of Motion Picture and Television Engineers in good standing residing within the geographic boundaries of any local Section shall be considered members of that Section.

Subsec. B. Should the enrolled voting membership of a Section fall below twenty, or should the technical quality of the presented papers fall below an acceptable level, or the average attendance at meetings not warrant the expense of maintaining that Section, the Board of Governors may cancel its authorization.

Sec. 3. Section Officers.

Subsec. A. The officers of each Section shall be a Chairman and a Secretary-Treasurer. When the technical quality of the presented papers and the average attendance of meetings reach a satisfactory level, the Board of Governors may authorize that the Section Chairman become ex officio a member of the Board of Governors. Each Section officer shall hold office for one year, or until his successor is chosen.

Sec. 4. Board of Managers. The Board of Managers shall consist of the Section Chairman, the Section Past-Chairman, the Section Secretary-Treasurer, and six voting members. Each manager of a Section shall hold office for two years. Vacancies shall be filled by appointment by the Board of Managers until the annual election of the Section.

Sec. 5. Section Elections. The officers and managers of a Section shall be voting members of the Society. All officers and managers shall be elected to their respective offices by a majority of ballots cast by the voting members residing in the geographical area of the Section. Not less than three months prior to the annual fall convention of the Society, nominations shall be presented to the Board of Managers of the Section by a Nominating Committee appointed by the Chairman of the Section, consisting of seven members, including a chairman. The committee shall be composed of the present Chairman, the Past-Chairman, two other members of the Board of Managers not up for election, and three other voting members of the Section not currently officers or managers of the Section. Nominations shall be made by a three-quarters affirmative vote of the total Nominating Committee. Such nominations shall be final, unless any nominee is rejected by a three-quarters vote of the Board of Managers, and in the event of such rejection the Board of Managers will make its own nomination.

The Chairman of the Section shall then notify the candidates of their nomination. From the list of acceptances, not more than three names for each vacancy shall be selected by the Board of Managers and placed on a letter ballot. A blank space shall be provided on this letter ballot under each office, in which space the name of any voting member other than those suggested by the Board of Managers may be voted for. The balloting shall then take place. The ballot shall be enclosed with a blank envelope and a business reply envelope bearing the local Secretary-Treasurer's address and a space for the member's name and

address. One of these shall be mailed to each voting member of the Society residing in the geographical area covered by the Section, not less than forty days in advance of the annual fall convention.

The voter shall then indicate on the ballot one choice for each office, seal the ballot in the blank envelope, place this in the envelope addressed to the Secretary-Treasurer, sign his name and address on the latter, and mail it in accordance with the instructions printed on the ballot. No marks of any kind except those above prescribed shall be placed upon the ballots or envelopes. Voting shall close seven days before the opening session of the annual fall convention. The sealed envelopes shall be delivered by the Secretary-Treasurer to his Board of Managers at a duly called meeting. The Board of Managers shall then examine the returned envelopes, open and count the ballots, and announce the results of the election.

The newly elected officers and managers shall take office on January 1, following their election.

Sec. 6. Section Business. The business of a Section shall be conducted by the Board of Managers.

Sec. 7. Section Expenses.

Subsec. A. At the beginning of each fiscal year, the Secretary-Treasurer of each Section shall submit to the Board of Governors of the Society a budget of expenses for the year.

Subsec. B. The Treasurer of the Society shall deposit with each Section Secretary-Treasurer a sum of money for current expenses, the amount to be fixed by the Board of Governors.

Subsec. C. The Secretary-Treasurer of each Section shall send to the Treasurer of the Society, quarterly, or on demand, an itemized account of all expenditures incurred during the preceding period.

Subsec. D. Expenses other than those enumerated in the budget, as approved by the Board of Governors of the Society, shall not be payable from the general funds of the Society without express permission from the Board of Governors.

Subsec. E. The Section Board of Managers shall defray all expenses of the Section not provided for by the Board of Governors from funds raised locally.

Subsec. F. The Secretary of the Society shall, unless otherwise arranged, supply to each Section all stationery and printing necessary for the conduct of its business.

Sec. 8. Section Meetings. The regular meetings of a Section shall be held in such places and at such hours as the Board of Managers may designate. The Secretary-Treasurer of each Section shall forward to the Sections Vice-President of the Society, not later than five days after a meeting of a Section, a statement of the attendance and of the business transacted.

Sec. 9. Constitution and Bylaws. Sections shall abide by the Constitution and Bylaws of the Society and conform to the regulations of the Board of Governors. The conduct of Sections shall always be in conformity with the general policy of the Society as fixed by the Board of Governors.

ARTICLE X

Student Chapters

Sec. 1. Student Chapters of the Society may be authorized in any college, university, or technical institute of collegiate standing. Upon written petition for the authorization of a Student Chapter, signed by twelve or more Society members, or applicants for Society membership, and the Faculty Adviser, the Board of Governors may grant such authorization.

Sec. 2. Chapter Membership.

Subsec. A. All members of the Society in good standing who are attending the designated educational institution shall be eligible for membership in the Student Chapter, and when so enrolled they shall be entitled to all privileges that such Student Chapter may, under the Constitution and Bylaws, provide.

Subsec. B. Should the membership of the Student Chapter fall below ten, or the average attendance of meetings not warrant the expense of maintaining the organization, the Board of Governors may cancel its authorization.

Sec. 3. Chapter Officers. The officers of each Student Chapter shall be a Chairman and a Secretary-Treasurer. Each Chapter officer shall hold office for one year, or until his successor is chosen. Where possible officers shall be chosen in May to take office at the beginning of the following school year. The procedure for holding elections shall be prescribed in the Administrative Practices.

Sec. 4. Faculty Adviser. A member of the faculty of the same educational institution shall be designated by the Board of Governors as Faculty Adviser. It shall be his duty to advise the officers on the conduct of the Chapter and to approve all reports to the Sections Vice-President and the Treasurer of the Society.

Sec. 5. Chapter Expenses. The Treasurer of the Society shall deposit with each Chapter Secretary-Treasurer a sum of money, the amount to be fixed by the Board of Governors. The Secretary-Treasurer of the Chapter shall send to the Treasurer of the Society at the end of each school year or on demand an itemized account of all expenditures incurred.

Sec. 6. Chapter Meetings. The Chapter shall hold at least four meetings per year. The Secretary-Treasurer shall forward to the Sections Vice-President of the Society at the end of each school year a report of the meetings for that year giving the subject, speaker and approximate attendance for each meeting.

ARTICLE XI

Amendments

Sec. 1. Proposed amendments to these Bylaws may be initiated by the Board of Governors or by a recommendation to the Board of Governors signed by ten voting members. Proposed amendments may be approved at any regular meeting of the Society at which a quorum is present, by the affirmative vote of two-thirds of the members present and eligible to vote thereon. Such proposed amendments shall have been published in the *Journal* of the Society, in the issue next preceding the date of the stated business meeting of the Society at which the amendment or amendments are to be acted upon.

Sec. 2. In the event that no quorum of the voting members is present at the time of the meeting referred to in Sec. 1, the amendment or amendments shall be referred for action to the Board of Governors. The proposed amendment or amendments then become a part of the Bylaws upon receiving the affirmative vote of three-quarters of the entire membership of the Board of Governors.

ARTICLE XII

Standards and Recommendations

Sec. 1. Purpose. The Society's "Recommended Practices," as well as American Standards sponsored by the Society, are adopted in the public interest; they are designed for the purpose of promoting and furthering the interests of the general public through the statement and dissemination of technical and engineering principles applicable to the motion-picture, television and the related arts and sciences.

Sec. 2. Definition. "Recommended Practices" of the Society and an American Standard sponsored by the Society describe a product, process or procedure with reference to one or more of the following: nomenclature, composition, tolerances, safety, operating characteristics, performance, rating, testing and the service for which designed.

Sec. 3. Use. Existence of a "Recommended Practice" of the Society does not in any respect require that any member or nonmember adhere to it, and such persons are free to accept or reject any adopted "Recommended Practice" as they see fit in the exercise of their individual discretion.

Advance Program

INTERNATIONAL CONGRESS 1960 5TH SMPTE ON HIGH-SPEED PHOTOGRAPHY

Sheraton-Park Hotel, Washington, D.C., October 16–22

This program represents the present and, in the main, the final arrangement of the Technical Sessions, but some slight deviations from the present scheduling may appear in the Final Program or may even take place during the Congress. Notification of such changes, should they occur, will be made at the appropriate time and place. Extensive and detailed information on arrangements both completed and tentative was published in the July *Journal* (pp. 489–498) and in the August *Journal* (pp. 548–550). The booklet on the 5th International Congress mailed to members and delegates contains in condensed form all relevant and helpful information available at the time of publication.

The two guest speakers, as listed under the heading "Congress Arrangements" in the July *Journal* are Crawford H. Greenewalt and J. Lewis Powell. A number of other distinguished guests will be present.

One of the highlights of the Congress will be an impressive military ceremony at Fort Meyer, Va. The ceremony, which will include some military maneuvers, will be dedicated to the Congress, marking its opening. Military buses will provide transporation from and back to the hotel, leaving at 4 P.M., arriving at Fort Meyer about 4:30 P.M. The ceremony will last about an hour.

Entertainment plans for Sunday evening originally included a performance by the Soldiers' chorus of the U. S. Army Field Band, 35 male voices under the direction of Captain Samuel Laboda, but it was decided that this performance should take place Thursday evening at the banquet.

An hour-long session on high-speed applications in biological and medical research has been scheduled for Friday evening, 8 P.M. (see Program, p. 670).

Questions concerning Technical Sessions, scheduling of papers and related matters may be directed to SMPTE Headquarters in New York (LOngacre 5-0172) or the Congress Chairman Max Beard, 10703 E. Nolcrest Drive, Silver Spring, Md. (HEmlock 4-7100, Ext. 639). If it is at all feasible inquiries should be made by telephone, at least during the week preceding the opening of the Congress.

It is recommended that everyone register on or before Sunday, October 16; otherwise there can be no assurance that radios will be issued in time for the first session on Monday. These are essential for the simultaneous interpretation.

For the Tentative Program for the week of ladies activities, see p. 623, which also has the Tentative Roster of Society Committee Meetings. The Catalogue of Equipment Exhibits begins on p. 684.

SPSE

SPSE Symposium on High-Speed Processing (in conjunction with the Congress) will be held on October 14 and 15 at the Shoreham Hotel, Washington, D.C. For registration information write Mr. Joseph Mangiaracina, 300 Brook Ave., Little Silver, N.J., or ask SMPTE headquarters. A Preliminary Program *is also available.*

OCTOBER 16 — SUNDAY 2:00 P.M. to 5:00 P.M. Registration

4:00 P.M. Military Ceremony Dedicated to the Congress, Fort Meyer, Virginia

8:30 P.M. Entertainment — Feature Film and Short

The full-length feature film is *I Aim at the Stars*, produced by Columbia; and the 30-minute short is *Man in Space*, produced by Walt Disney. The feature film is based on the life of Wernher von Braun, world-famous rocket scientist. It was filmed in Munich. The short combines live action and animation to dramatize suggested methods of getting Man into Space, and shows in detail the launching of an Earth satellite.

OCTOBER 17 — MONDAY 8:00 A.M. Registration

——— MONDAY 9:30 A.M. SESSION: Short-Duration Light Sources .....

Holdover in Xenon Flashlamps

HAROLD E. EDGERTON and DAVID CAHLANDER, Massachusetts Institute Technology, Cambridge, Mass.

When a flashlamp is required to flash at high rates, the charging circuit is required to supply more current. Eventually, a condition arises where the flashlamp does not deionize but goes into a continuous arc that is called "holdover." Conditions for the limiting frequency in terms of circuit and lamp volt-ampere characteristics are given. Experimental data on several flashlamps are presented. Circuits which force a flashlamp to operate at high frequency even if it does not deionize are discussed.

Le "pontage de l'arc" dans les lampes éclair au xénon

HAROLD E. EDGERTON et DAVID CAHLANDER, Massachusetts Institute of Technology, Cambridge, Mass.

Quand on exige d'une lampe-éclair qu'elle flamboie à de hautes fréquences, il est nécessaire que le circuit de charge fournisse davantage de courant. Eventuellement, il peut arriver un moment où la lampe-éclair ne désionise plus, mais forme un arc continu; cet incident est connu sous le nom de "pontage de l'arc." Les auteurs indiquent les conditions pour la fréquence limitatrice en fonction des caractéristiques volts-ampères du circuit et des lampes. L'article présente aussi des données expérimentales sur plusieurs lampes-éclair. Une description est donnée des circuits qui forcent une lampe-éclair à fonctionner à haute fréquence même si elle ne désionise pas.

Nachleuchten in Xenon-Blitzlampen

HAROLD E. EDGERTON and DAVID CAHLANDER, Massachusetts Institute of Technology, Cambridge, Mass.

Wenn eine Blitzlampe in rascher Aufeinanderfolge zu leuchten hat, so muss der aufladende Stromkreis eine grössere Menge Strom liefern. Dies führt schliesslich zu einem Zustand, in welchem die Blitzlampe nicht entionisiert wird sondern in einen dauernden Lichtbogen übergeht, den man "holdover" (Überbleibsel) nennt. Der Artikel gibt die Daten der maximalen Frequenzen in der Form von Volt-Ampere-Charakteristiken für Stromkreis und Lampe. Auch werden experimentelle Daten für verschiedene Blitzlampen gebracht. Weiterhin folgt eine Erörterung der Stromkreise, welche eine Blitzlampe dazu zwingen mit hoher Frequenz zu arbeiten, selbst dann wenn sie nicht entionisiert ist.

The Control of High-Power Xenon Flashes by Magnetic Switching

E. J. G. Beeson, A. E. I. Lamp and Lighting Co. Ltd., Leicester, England

The xenon-arc discharge is very susceptible to a magnetic field and the arc can be deflected to extinction. In this way a lamp can fulfil a dual purpose by emitting light radiation while functioning as its own circuit breaker. Investigations have centered around a 2-kw design of a compact-source xenon lamp with increasing gas pressures and with lamp currents of up to 1,000 amp. By the use of a magnetic field to extinguish the arc and thereby break the lamp current, substantially square-wave pulses of light are obtained in the region of 10 to 100 msec. With these high lamp currents the lead-acid battery provides a satisfactory source of power and with light flashes of up to 50 kw the arc characteristics and the light efficiency output have been studied. Comparisons are also made with earlier discharge lamp designs which are of particular interest for high-speed photography.

Magnetic arc switching is already being used successfully as a means of providing an occulting light in the Dungeness lighthouse. Higher flash powers are switched with shorter durations enabling higher-speed camera operation and entering a field where rotating-mirror cameras demand still higher light intensities.

La commande des flashes au xénon de grande puissance par commutation magnétique

E. J. G. Beeson, A.E.I. Lamp and Lighting Co., Ltd., Leicester, Angleterre

La décharge de l'arc au xénon est très sensible à un champ magnétique, de sorte que l'arc peut être dévié jusqu'à extinction. De cette manière, une lampe peut remplir une double fonction en émettant une radiation lumineuse tout en fonctionnant comme son propre coupe-circuit. Les études ont porté surtout sur un type de 2 kw de lampe au xénon à source compacte caractérisé par des pressions de gaz croissantes et des courants de lampe allant jusqu'à 1000 amp. En utilisant un champ magnétique pour éteindre l'arc et ainsi interrompre le courant de la lampe, on obtient essentiellement des pulsations de lumière à ondes de profil carré dans la zone de 10 à 100 msec. Avec ces courants de lampe élevés l'accumulateur à plomb et acide constitue une source d'énergie satisfaisante, et avec des éclairs lumineux d'un maximum de 50 kw on a également étudié les caractéristiques de l'arc et le débit du rendement lumineux. L'auteur fait aussi des comparaisons avec des types antérieurs de lampes à décharge qui sont d'un intérêt spécial pour la photographie à grande vitesse.

Le système de commutation magnétique de l'arc est déjà utilisé avec succès pour assurer un feu intermittent dans le phare de Dungeness. On obtient des puissances-éclair plus élevées et de durées plus courtes, ce qui permet de faire fonctionner les appareils de prise de vues à des vitesses plus grandes et d'aborder un domaine où les caméras à miroir tournant exigent des intensités de lumière encore plus élevées.

Die Regelung von Hochleistungs-Xenonblitzen durch magnetische Schaltung

E. J. G. Beeson, A.E.I. Lighting Co. Ltd, Leicester, England

Die Xenon-Lichtbogenentladung wird durch ein magnetisches Feld stark beeinflusst und der Lichtbogen kann bis zum völligen Erlöschen abgelenkt werden. Auf diese Weise kann eine Lampe einen doppelten Zweck erfüllen, indem sie sowohl Licht ausstrahlt als auch gleichzeitig als ihr eigener Stromunterbrecher wirkt. Die Untersuchungen behandeln hauptsächlich ein 2 kW-Modell einer kompakten Xenonlampe mit ansteigenden Gasdrücken und Lampenströmen bis zu 1000 A. Dadurch dass ein Magnetfeld zum Löschen des Lichtbogens und damit zum Unterbrechen des Lampenstroms verwendet wird, ergeben sich fast Rechteckwellen-Lichtimpulse von 10 bis zu 100 Millisekunden. Die Blei und Säure-Batterie ist eine zufriedenstellende Kraftquelle für diese hohen Lampenströme und es wurden die Charakteristiken des Lichtbogens und der Nutzleistung an Licht an Lichtblitzen bis zu 50 kW untersucht. Es werden auch Vergleiche mit älteren Modellen von Entladungslampen angestellt, die für die Hochgeschwindigkeits-Photographie von besonderem Interesse sind.

Das Schalten mit magnetischem Lichtbogen wird bereits mit Erfolg dazu benützt ein aussetzendes Feuer im Leuchtturm von Dungeness zu betreiben. Grössere Blitzstärken werden mit kürzeren Dauerzeiten geschaltet, wodurch eine grössere Geschwindigkeit der Kamerabetätigung ermöglicht wird und man in das Gebiet kommt, wo Kameras mit rotierenden Spiegeln eine noch höhere Lichtintensität erfordern.

Flashlight Source Measurement

George H. Lunn, Atomic Weapons Research Establishment, Aldermaston, Berks, England

A method of measuring the light-time variations of flashlight sources is described. A streak camera (after Brixner) has a neutral density step wedge over the slit; the light source to be recorded is arranged to illuminate the slit and step wedge uniformly at all points. Thus a number of light output/time records are produced simultaneously, the ratio of incident light to each record being known. Microdensitometer studies of these records are made, from which logarithmic and linear graphs result. H & D curves of emulsion/developer combinations are also produced at submicrosecond exposure times. The advantage of logarithmic display is discussed.

Le mesurage des sources de lumière-éclair

George H. Lunn, A. W. R. E., Aldermaston, Berks, Angleterre

L'auteur décrit un procédé pour mesurer les variations lumière-temps des sources de lumière-éclair. Une caméra à stries (d'après Brixner) est munie d'une clavette à crans de densité neutre au-dessus de la fente, et la source de lumière à enregistrer est disposée de manière à éclairer la fente et la clavette à crans d'une manière uniforme en tous points. On obtient ainsi simultanément plusieurs enregistrements du débit lumineux en fonction du temps, le rapport entre la lumière incidente et chaque enregistrement étant connu. On fait des études au microdensitomètre de ces enregistrements, d'où l'on dérive des graphiques logarithmiques et linéaires. On détermine aussi des courbes H et D de combinaisons émulsions/révélateurs pour des temps d'exposition de l'ordre des submicrosecondes. L'auteur examine les avantages des présentations logarithmiques.

Das Messen von Blitz-Lichtquellen

George H. Lunn, A. W. R. E., Aldermaston, Berks, England

Der Autor beschreibt eine Methode zum Messen von Lichtund Zeitvariationen in Blitzlichtern. Eine Schlierenkamera (nach Brixner) trägt einen Stufenkeil über dem Schlitz und die zu messende Lichtquelle ist so eingestellt, dass sie den Schlitz und den Stufenkeil, der von neutraler Dichte ist, an allen Punkten gleichmässig beleuchtet. Auf diese Weise werden gleichzeitig eine ganze Anzahl von Aufzeichnungen über Lichtausbeute/Zeit gemacht, wobei das Verhältnis des einfallenden Lichts zu jeder Aufzeichnung bekannt ist. Es werden dann Mikrodensitometer-Studien dieser Aufzeichnungen vorgenommen, aus denen sich logarithmische und lineare D'agramme ergeben. Auch H und D Kurven verschiedener Emulsions-Entwickler Kombinationen werden bei Belichtungszeiten von unter einer Mikrosekunde angefertigt. Der Vorteil logarithmischer Darstellung wird behandelt.

Use of High-Explosive Lamps for Photography by the Schardin Method

Louis Deffet and René Vanden Berghe, Centre de Recherches Scientifiques et Techniques Pour l'Industrie des Produits Explosifs, Brussels, Belgium

This transparency method makes it possible to obtain photographic records of explosive phenomena which have a considerable destructive effect and a very intense self-luminosity. It consists mainly in replacing the sparks of the Cranz-Schardin method with explosive flash-lamps which do not detonate in an argon atmosphere. The intensity of the luminous flux supplied by these lamps has made it possible to arrange recording conditions, so that the unwanted luminosity of the object can be

Utilisation de lampes explosives pour la photographie par le système Schardin

Louis Deffet et René Vanden Berghe, Centre de Recherches Scientifiques et Techniques Pour l'Industrie des Produits Explosifs, Bruxelles, Belgique

Cette méthode par transparence apporte une solution à l'enregistrement photographique des phénomènes explosifs présentant un effet destructeur important et une luminosité propre très intense. Elle consiste essentiellement à remplacer les étincelles du système Cranz-Schardin par des lampes éclairs explosives ne détonant pas dans une atmosphère d'argon. L'intensité du flux lumineux émis par ces lampes explosives a permis de combiner des conditions de prises de vues entrainant une élimination totale des luminosités parasites du sujet.

Die Verwendung von Sprengstofflampen für die Photographie nach der Schardin-Methode

Louis Deffet und René Vanden Berghe, Centre de Recherches Scientifiques et Techniques Pour l'Industrie des Produits Explosifs, Brüssel, Belgien

Diese Transparenz-Methode ermöglicht es photographische Aufzeichnungen von Explosionsphänomenen zu machen, die eine bedeutende Zerstörungskraft und eine sehr intensive Eigenluminosität haben. Sie besteht in der Hauptsache darin, dass die Funken der Cranz-Schardin Methode durch Sprengstoff- Blitzlampen ersetzt werden die in einer Argon-Atmosphäre nicht detonieren. Die Intensität des durch diese Lampen gelieferten Lichts ermöglichte es, die aufzunehmenden Umstände zu kombinieren, wodurch parasitische Luminositäten des Objekts vollkommen ausgeschaltet wurden. Die Synchronisierung der verschiedenen Sprengstoff-

circumvented. The synchronization of the various explosive lamps is assured by the use of a detonating cord. The framing rate can attain 1,000,000 frames/sec at an exposure time of the order of 10^{-1} μsec per image.

La synchronisation des différentes lampes explosives est assurée par du cordeau détonant. La fréquence de prise de vues peut atteindre 1.000.000 images par seconde avec un temps de pose par image de l'ordre de 10^{-1} μsec.

lapen wird durch Verwendung einer detonierenden Zündschnur gesichert. Die Bildgeschwindigkeit kann 1.000.000 Aufnahmen/s bei einer Belichtungszeit der Grössenordnung 10^{-1} Mikrosekunde je Aufnahme erreichen.

Explosive Flashlight: A New Development in an Explosive Light Source

J. Gershon and R. H. Stressau, Armour Research Foundation of Illinois Institute of Technology, Chicago

An explosive flashlight has been developed at Armour Research Foundation for use as an ultra-high-speed photographic light source. The flashlight consists of a long Plexiglas cylinder 2 in. ID by 2¼ in. OD, the inside wall is partially lined with du Pont EL 506A-8 sheet explosive and the interior is filled with argon gas. The duration of illumination is controlled by the length of the cylinder; the light reaches the required intensity in 10 μsec and has no effective tail. The light intensity is sufficient for microsecond color photography.

The light source also has the advantages of being (1) easily handled (because of its light weight and the safety of du Pont sheet explosive); (2) easily preassembled and stored; and (3) waterproof. Since the duration of illumination can be varied, the flashlight is an appropriate light source for photographic applications where the light duration must match varying event times. This flashlight has been used as a light source for the Beckman & Whitley Model 189 Framing Camera.

Une lampe-éclair explosive: Nouvelle réalisation dans une source de lumière explosive

J. Gershon et R. H. Stressau, Armour Research Foundation of Illinois Institute of Technology, Chicago

La Fondation de Recherches Armour a mis au point une lampe-éclair explosive destinée à être employée comme source de lumière dans la photographie ultra-rapide. Cette lampe-éclair consiste en un long cylindre en plexiglas d'un diamètre intérieur de 2 pouces et d'un diamètre extérieur de 2¼ pouces; la paroi intérieure est revêtue partiellement d'explosif en feuille E L 506A-8 de du Pont et l'intérieur est rempli de gaz argon. La durée d'éclairement est réglée par la longueur du cylindre; la lumière atteint l'intensité requise en 10 microsecondes et n'a pas de traînée effective. L'intensité lumineuse est suffisante pour la photographie en couleur de l'ordre des microsecondes.

La source de lumière a aussi comme avantages (1) d'être facilement maniable (en raison de sa légèreté et de la sécurité de l'explosif en feuille de du Pont), (2) d'être facilement monté à l'avance et rangé et (3) d'être hydrofuge. Vu que la durée d'éclairement peut être modifiée, cette lampe-éclair est une source de lumière particulièrement appropriée pour les applications photographiques où la durée de lumière doit être adaptée à des durées variables des processus étudiés. Cette lampe-éclair a été employée comme source de lumière pour la caméra multi-images Modèle 189 de Beckman & Whitley.

Sprengstoff-Blitzlicht: eine Neuerung in Sprengstoff-Lichtquellen

J. Gershon und R. H. Stressau, Armour Research Foundation of Illinois Institute of Technology, Chicago

Bei der Armour Research Foundation wurde ein Sprengstoff-Blitzlicht zur Verwendung als Höchstgeschwindigkeits-Lichtquelle für die Photographie entwickelt. Das Blitzlicht besteht aus einem langen Zylinder aus Plexiglas mit einem inneren Durchmesser von 2 Zoll und einem äusseren Durchmesser von 2¼ Zoll, dessen Innenwand teilweise mit dem DuPont Sprengstoff E L 506A-8 in Blattform belegt und der mit Argon gefüllt ist. Die Beleuchtungsdauer wird durch die Länge des Zylinders geregelt. Das Licht erreicht die nötige Intensität in 10 Mikrosekunden und hat kein wirksames Nachleuchten. Die Lichtintensität genügt für Farbenaufnahmen in Mikrosekunden.

Diese Lichtquelle hat folgende Vorteile: 1) man kann leicht damit hantieren (wegen ihres geringen Gewichts und der Gefahrlosigkeit des DuPont Blatt-Sprengstoffes); 2) sie ist leicht im Voraus zusammenzusetzen und aufzubewahren; 3) sie ist wasserdicht. Da die Leuchtdauer geändert werden kann, ist das Blitzlicht eine geeignete Lichtquelle für photographische Zwecke, bei denen die Leuchtdauer den Zeitspannen verschiedener Ereignisse angepasst werden muss. Dieses Blitzlicht wurde als Lichtquelle für die Beckman and Whitley Reihenbildkamera Modell 189 verwendet.

High-Intensity Explosive Light Sources

Zev Pressman, Poulter Laboratories, Stanford Research Institute, Menlo Park, Calif.

An explosive light source has been developed to produce daylight-quality illumination intense enough for reflected light color photography using ultra-high-speed cameras. Previously used explosive "candles" required much more high explosive and emitted rapidly fading light that was considerably less brilliant. Sheet explosives are combined with aluminized Mylar as a mirror-like reflector to make a highly efficient pyramid-shaped candle that can cover from 10 to 200 μsec according to need. The luminous intensity is maintained by a diverging explosive area as the detonation wave travels the length of the argon-filled container. In addition to increased time and brightness efficiency, this more compact design illuminates more uniformly and scatters less light outside the subject area.

The advantages of using various concentrations of argon as well as dilutions and admixtures with air, krypton and xenon were investigated. Methods are proposed whereby still more intense light can be obtained by substituting krypton and xenon, or adding these gases to the argon. The relative intensities of the various light sources were all compared and measured by photometric studies and calibration of films produced by photographing the light with a high-speed framing camera.

Des sources de lumière explosive à haute intensité

Zev Pressman, Poulter Laboratories, Stanford Research Institute, Menlo Park, Californie.

On a réalisé une source de lumière explosive capable de produire un éclairement de qualité "lumière du jour" qui est d'une intensité suffisante pour la photographie en couleur par lumière réfléchie employant des caméras ultra-rapides. Les "bougies" explosives utilisées antérieurement nécessitaient un explosif beaucoup plus puissant et émettaient une lumière notablement moins brillante qui s'affaiblissait rapidement. On combine des explosifs en feuille à du Mylar aluminisé sous forme de réflecteur-miroir de manière à constituer une bougie pyramidale de haute efficacité qui peut couvrir de 10 à 200 μsec suivant le besoin. L'intensité lumineuse est maintenue par une zone explosive divergente pendant que l'onde produite par la détonation parcourt la longueur de la bougie remplie d'argon. Outre l'amélioration en durée et en clarté, ce type plus compact de source lumineuse éclaire plus uniformément et disperse moins de lumière en dehors de la zone de l'objet photographié.

L'auteur rend compte des avantages tirés de l'emploi de diverses concentrations d'argon, ainsi que de dilutions et additions d'air, de krypton et de xénon. Il propose des méthodes par lesquelles on peut obtenir une lumière encore plus intense en substituant le krypton et le xénon ou en ajoutant ces gaz à l'argon. Les intensités relatives des diverses sources de lumière ont été toutes comparées et mesurées par des études photométriques et par étalonnage des films obtenus en photographiant la lumière avec une caméra multi-images à grande vitesse.

Hochintensitäts-Sprengstofflichtquellen

Zev Pressman, Poulter Laboratories, Stanford Research Institute, Menlo Park, Kalifornien

Es wurde eine Sprengstoff-Lichtquelle entwickelt um eine tagelichtähnliche Beleuchtung zu liefern, die intensiv genug ist bei reflektiertem Licht, unter Verwendung von Höchstgeschwindigkeits-Kameras, Farbenphotographien machen zu können. Die früher verwendeten Sprengstoff-"Kerzen" benötigten viel mehr Sprengstoff und gaben ein schnell vergängliches Licht von bedeutend geringerer Brillianz. Sprengstoffe in Blattform werden mit aluminiumisiertem Mylar als spiegelähnlichem Reflektor kombiniert, um eine sehr wirksame pyramidenförmige Kerze herzustellen, welche je nach Bedarf 10 bis 200 Mikrosekunden ausreicht. Die Lichtintensität wird dadurch beibehalten, dass das Explosionsgebiet divergiert sobald die Detonationswelle sich entlang dem argongefüllten Behälter fortpflanzt. Ausser der vergrösserten Dauer und Helligkeitsleistung ist diese Ausführung auch mehr kompakt, beleuchtet gleichmässiger und verstreut weniger Licht ausserhalb des Objektraums.

Es wurden die Vorteile untersucht, die sich durch Verwendung verschiedener Konzentrationen von Argon sowie durch Verdünnungen und Zusätze von Luft, Krypton und Xenon ergeben. Es werden auch Methoden vorgeschlagen, nach welchen sich ein noch intensiveres Licht dadurch erzielen lässt, dass das Argon durch Krypton und Xenon ersetzt oder damit versetzt wird. Die relativen Intensitäten der verschiedenen Lichtquellen wurden alle verglichen und gemessen, indem man photometrische Untersuchungen und die Kalibrierung von Filmen vornahm, die beim Photographieren des Lichts mit einer Hochgeschwindigkeits-Bildreihenkamera hergestellt wurden.

High-Intensity, Fractional Microsecond Light Sources

EARLE B. BROWN, Farrand Optical Co., New York

High-intensity light sources have been developed for military applications in optical ranging, communications and navigation. These sources provide a small area electric spark with a peak brightness of approximately 50 million candles/sq. cm, and a duration of 0.5 μsec or less.

These sparks may be operated at resonant frequencies or triggered accurately by triggering electrodes. Normal frequencies of operation up to several kilocycles is possible under certain conditions. Spectrographic measurements indicate an effective blackbody temperature of the order of 30,000 K. Developmental work has included experiments with spark atmospheres of various compositions and pressures.

Millimicrosecond Light Source

HEINZ FISCHER, Air Force Research Division, Hanscom Field, Bedford, Mass.

Short light pulses in the millimicrosecond (mμsec) range have been reported recently by a number of authors, but the intensities were exceedingly small and barely adequate for technical applications. An open-air microsecond light source has been based on a coaxial capacitor discharge of minimum inductance, and greatly increased brightness has resulted.

Minimum inductance means maximum energy input into the gap at the shortest pulse length. As a result of this consideration, some time ago a *toroidal* capacitor was developed to surround the gap coaxially and a simple submicrosecond light source applying this geometry was described.(Heinz Fischer, *J. Opt. Soc. Am.*, **47**: 981 (1957). In the meantime, by careful design and improved technology, the inductance could be reduced close to its absolute possible minimum, approximately one millimicrohenry.

Light pulses with a 2-mμsec rise time and a half-width of ~ 6 mμsec are produced, the brightness exceeding 10 million candles/sq cm. Intensities of over 20,000 candles are measured. The methods of measurement are described. The relationship between the arc current and the brightness is established over a wide range of pulse widths and the shape of the light pulse is studied. Spectral measurements in 1 atmosphere of air confirm that the spectrum is continuous between 6000 and 2000 A during the time of the current maximum — the intensity increasing strongly in the ultraviolet.

Single-shot exposures of objects, *f*/1.5 lens, Tri-X Film, and normal development show marginal density in reflected light at 30 cm distance; in transparent, the picture is adequate. Silhouette pictures taken through an *f*/8 lens, 50-cm focal length, show a maximum photographic density of D > 0.8 against a background of ~ 0.35; the maximum density is beyond the background by an intensity factor of 16.

New Data on Physical and Technical Parameters of Flash Tubes

I. S. MARSHAK and L. I. SHCHOUKIN, Institute of Chemical Physics, Academy of Sciences of the USSR, Moscow

(*To be presented by title only.*)

Des sources lumineuses de haute intensité à microsecondes fractionnaires

EARLE B. BROWN, Farrand Optical Co., New York

On a perfectionné des sources de lumière à haute intensité en vue d'applications dans le réglage optique du tir, les communications et la navigation. Ces sources produisent une étincelle électrique de surface restreinte qui a un éclat maximum d'environ 50 millions de bougies par cm² et une durée de 0,5 μsec ou moins.

Ces étincelles peuvent être produites à des fréquences résonnantes ou être déclenchées avec précision au moyen d'électrodes de déclenchement. Il est possible d'obtenir, dans certaines conditions, des fréquences normales de fonctionnement allant jusqu'à plusieurs kilocycles. Les mesures spectrographiques indiquent une température effective de corps noir de l'ordre de 30.000 K. Parmi les travaux de recherches effectués ont figuré des essais avec des atmosphères d'étincelles de compositions et pressions diverses.

Une source de lumière de l'ordre des millimicrosecondes

HEINZ FISCHER, Air Force Research Division, Hanscom Field, Bedford, Mass.

Nombre d'auteurs ont récemment fait rapport sur de courtes pulsations lumineuses d'une durée de l'ordre des millimicrosecondes, mais les intensités en étaient entrêmement faibles et à peine suffisantes pour les applications techniques. On a maintenant réalisé en plein air une source lumineuse de l'ordre des millimicrosecondes en utilisant une décharge à inductance minimum de condensateur coaxial et l'on a ainsi obtenu un éclat d'une intensité notablement accrue.

L'inductance minimum se traduit par une absorption maximum d'énergie dans l'intervalle à la longueur de pulsation la plus courte. Sur la base de ce principe, on a construit il y a quelque temps un condensateur *toroïdal* qui entoure coaxialement l'intervalle et l'on a décrit une simple source lumineuse de l'ordre des submicrosecondes qui applique cette disposition géométrique. (Heinz Fischer, *J. Opt. Soc. Am. 47*: 981 (1957). Entretemps, par une construction soignée et une technique perfectionnée, on a pu réduire l'inductance à une valeur très voisine de son minimum absolu éventuel, à savoir environ un millimicrohenry.

On produit des pulsations lumineuses d'une durée ascendante de 2 mμsec et d'une mi-largeur de ~6 mμsec; leur éclat dépasse 10 millions de bougies par cm². On a mesuré des intensités de plus de 20.000 bougies. L'auteur décrit les méthodes de mesure employées. La relation entre l'intensité du courant de l'arc et l'éclat est établie sur une ample gamme de largeurs de pulsation et la forme de la pulsation lumineuse est étudiée en détail. Des mesures spectrales dans une atmosphère d'air confirment que le spectre est continu entre 6000 et 2000 amp pendant la durée du maximum de courant—l'intensité augmentant fortement dans la zone ultraviolette.

Des expositions d'objets à prise de vue unique, une lentille de *f*/1,5, une pellicule de Tri-X et un développement normal montrent une densité marginale dans la lumière réfléchie à une distance de 30 cm; dans la lumière diffuse, l'image est satisfaisante. Des sciographies prises au moyen d'une lentille de *f*/8 avec une distance focale de 50 cm accusent une densité photographique maximum de D>0,8 contre un arrière-plan de ~ 0,35; la densité maximum dépasse l'arrière-plan d'un facteur d'intensité de 16.

Nouveaux donnés sur les paramètres physiques et techniques des tubes-éclair

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Hochintensitäts-Lichtquellen für Mikrosekunden-Bruchteile

EARLE B. BROWN, Farrand Optical Co., New York

Zur militärischen Verwendung beim optischen Entfernungsmessen, zur Nachrichtenübermittlung und für die Schiffahrt wurden hochintensive Lichtquellen entwickelt. Sie liefern einen elektrischen Funken in kleinem Raum, der eine Spitzenhelligkeit von ca. 50 Millionen Kerzenstärken/cm² und eine Dauer von 0,5 Mikrosekunden oder darunter hat. Diese Funken können entweder bei Resonanzfrequenzen betrieben oder, mit Hilfe von Auslöseelektroden, genau ausgelöst werden. Unter gewissen Umständen sind normale Frequenzen bis zu mehreren Kilohertz möglich. Spektrographische Messungen zeigen eine wirksame Schwarzkörpertemperatur von ca. 30.000 Kelvin. Zu den Entwicklungsarbeiten gehörten auch Experimente mit Funkenatmosphären verschiedener Gase und Drücke.

Millimikrosekunden-Lichtquelle

HEINZ FISCHER, Air Force Research Division, Hanscom Field, Bedford, Mass.

Eine Anzahl von Autoren hat in jüngster Zeit über kurze Lichtimpulse im Gebiet der Millimikrosekunden berichtet, doch waren die Helligkeiten äusserst gering und kaum genügend für eine technische Anwendung. Eine Freiluft-Lichtquelle für solche Blitze beruhte auf einer koaxialen Kondensatorentladung geringster Induktivität und das Ergebnis war eine stark gesteigerte Helligkeit.

Geringste Induktivität bedeutet maximale Energiezufuhr zu dem Luftspalt bei geringstmöglicher Impulsdauer. Als Ergebnis dieser Betrachtung wurde vor einiger Zeit ein toroidförmiger Kondensator entwickelt, um den Spalt koaxial zu umgeben und es wurde eine einfache Quelle für Blitze von weniger als einer Mikrosekunde beschrieben, die dieses Prinzip anwendet. (Heinz Fischer, *J. Opt. Soc. Am.* **47**: 981 (1957). In der Zwischenzeit konnte die Induktivität durch sorgfältige Bauweise und verbesserte Technik so verringert werden, dass sie das absolut mögliche Minimum von ungefähr 1 Millimikrohenry erreicht.

Es wurden Lichtimpulse erzielt, die eine Anstiegszeit von 2 Millimikrosekunden und eine halbe Weite von ~ 6 Millimikrosekunden haben, wobei die Helligkeit über 10 Millionen Kerzenstärken/cm² beträgt. Intensitäten von über 20.000 Kerzenstärken wurden gemessen und die Messmethoden werden in dem Artikel beschrieben. Das Verhältnis zwischen Lichtbogenstrom und Helligkeit für die verschiedenen Impulsweiten sowie die Form der Lichtimpulse werden betrachtet. Spektralmessungen bei 1 Atm. Luft bestätigen, dass das Spektrum während der Zeit des Strommaximums zwischen 6000 und 2000 A kontinuierlich ist und dass die Intensität im Ultraviolett stark ansteigt.

Einzelaufnahmen von Objekten bei einer Öffnung von 1:1½ mit Tri-X Film bei normalem Entwickeln zeigen noch erkennbare Dichte bei reflektiertem Licht auf 30 cm Entfernung; bei durchscheinendem Licht ist das Bild hinreichend gut. Schattenbilder durch eine Linse 1:8 und 50 cm Brennweite zeigen eine maximale photographische Dichte von D > 0,8 gegen einen Hintergrund von ~ 0,35; die grösste Dichte liegt bei einem Intensitätsfaktor von 16 über den Hintergrund hinaus.

Neue Angaben über physische und Technische Parameter von Blitzröhren

I. S. MARSHAK und L. I. SHCHOUKIN, Institut der chemischen Physik, Akademie der Wissenschaften der UdSSR, Moskau

——— MONDAY 11:45 P.M. SMPTE Business Meeting

—— MONDAY 2:00 P.M. SESSION: Applications of Light in High-Speed Photography

High-Speed Photography Using Ultraviolet Light to Eliminate Visible Light Masking in Self-Illuminating Events

R. Wayne Anderson, The Dow Chemical Co., Midland, Mich.

In most high-speed, self-illuminated events such as arc-welding, Plasmatron studies and combustion of solid fuels, the intensity of the illumination masks many of the important details that occur during the event. To eliminate this undesirable overexposure, a method has been devised to filter out light in the visible spectrum and make higher-speed photographs using only the near ultraviolet light produced in events of this nature. In cases where insufficient ultraviolet light is produced by the event, there are other methods of producing enough ultraviolet to make higher speed exposures. These techniques have also been used to penetrate flame barriers and to produce sufficient contrast between incandescent materials in high-temperature furnaces.

Emploi de la lumière ultraviolette en photographie à grande vitesse pour éliminer le masquage par la lumière visible dans les processus auto-éclairants

R. Wayne Anderson, The Dow Chemical Co., Midland, Mich.

Dans la plupart des processus auto-éclairés à grande vitesse, tels que la soudure à l'arc, les études Plasmatron et la combustion des combustibles solides, l'intensité de l'éclairement masque une grande partie des détails importants qui se présentent au cours du processus. Afin d'éliminer cette surexposition gênante, on a perfectionné une méthode qui permet d'intercepter la lumière par filtrage dans le spectre visible et d'obtenir plus rapidement des photographies utilisant seulement la lumière quasi-ultraviolette produite dans les processus de ce genre. Dans les cas où une lumière ultraviolette insuffisante est produite dans le processus considéré, il existe d'autres méthodes permettant de produire une lumière ultraviolette suffisante pour obtenir des expositions plus rapides. Ces techniques ont été également utilisées pour pénétrer les barrières de flammes et pour produire un contraste suffisant entre les matières incandescentes dans les fours à haute température.

Hochgeschwindigkeitsphotographie bei ultraviolettem Licht zur Vermeidung des Abdeckens durch sichtbares Licht bei selbstbeleuchteten Vorgängen

R. Wayne Anderson, The Dow Chemical Co., Midland, Mich.

Bei den meisten selbstbeleuchteten Hochgeschwindigkeits-Vorgängen, wie Lichtbogenschweissung, Plasmatronstudien und Verbrennung fester Brennstoffe, verdeckt die Intensität der Beleuchtung viele der wichtigen Einzelheitern, die sich während des Vorgangs abspielen. Um diese unerwünschte Uberbelichtung auszuschalten wurde eine Methode gefunden, um das Licht des sichtbaren Spektrums auszufiltern und Aufnahmen mit höherer Geschwindigkeit zu machen, bie denen nur das fast ultraviolette Licht derartiger Vorgänge benutzt wurde. In solchen Fällen, in denen der Vorgang selbst nicht genügend ultraviolettes Licht produziert, gibt es andere Mittel zur Erzeugung von genügend starkem ultraviolettem Licht um Aufnahmen bei hoher Geschwindigkeit zu gestatten. Diese Verfahren wurden auch dazu verwendet, Flammenhindernisse zu durchdringen und genügende Kontraste zwischen glühenden Stoffen in Ofen mit Hochtemperatur zu erzielen.

Application of the Multiple-Spark Camera for the Study of Events Requiring a Large Quantity of Information

H. Schardin, Institut Franco-Allemand de Recherches, St.-Louis, France

The principle of the multiple-spark camera consists — as is well known — in obtaining a purely optical image separation by means of illuminating spark gaps, thereby eliminating any mechanical movement. There are disadvantages: the parallax appearing with objects which are too far spread in depth; the necessity of additional provisions for self-luminous events; and the limited total number of images with the presently usual type of operation.

This article reports on a new arrangement, which eliminates the last listed disadvantage. The installation consists of 5 series of 10 spark gaps each. The film on the respective drums is 25 cm wide and 1 m long so that, at a film speed of 100 m/sec and an image height of 2 cm a maximum total of 2,500 pictures of an event can be taken, or 5,000 at an image height of 1 cm. The picture frequency can be increased to 500,000/sec at 2 cm height and to 1,000,000/sec at 1 cm height. This results in an extremely large quantity of information.

L'application de la caméra à étincelles multiples pour l'étude de processus nécessitant une grande quantité d'informations

H. Schardin, Institut Franco-Allemand de Recherches, St.-Louis, France

Le principe de la caméra à étincelles multiples consiste — comme chacun sait — à obtenir une séparation d'images purement optique au moyen d'intervalles à étincelles lumineuses, ce qui élimine tout mouvement mécanique. Ce système a certains inconvénients, à savoir: la parallaxe qui se présente dans le cas d'objets trop étalés en profondeur, la nécessité de dispositifs supplémentaires pour les processus auto-lumineux, et le nombre total d'images qui est limité avec le mode de fonctionnement du type usuel.

Le présent article décrit un nouveau systéme qui élimine le dernier des inconvénients cités ci-dessus. Cette installation se compose de 5 séries de chacune 10 intervalles d'étincelles. Le film employé sur les tambours respectifs a 25 cm de large et 1 mètre de long de sorte que, à une vitesse de film de 100 m/sec. et une hauteur d'image de 2 cm, on peut prendre un total maximum de 2.500 images d'un processus donné ou 5.000 à une hauteur d'image de 1 cm. La fréquence d'images peut être portée à 500.000 par seconde à une hauteur de 2 cm et à 1.000.000 par seconde à une hauteur de 1 cm. Il en résulte une quantité extrêmement élevée d'informations.

Die Anwendung der Mehrfachfunkenkamera bei der Untersuchung von Vorgängen, die eine hohe Gesamtinformation verlangen

H. Schardin, Institut Franco-Allemand de Recherches, St.-Louis, Frankreich

Das Prinzip der Mehrfachfunkenkamera besteht bekanntlich darin, dass man mithilfe von getrennten Belauchtungsfunkenstrecken eine rein optische Bildtrennung vornimmt, so dass jede mechanische Bewegung vermieden wird. Als Nachteile können gelten die auftretende Parallaxe bei räumlich zu tief ausgedehnten Objekten, die Notwendigkeit zusätzlicher Verkehrungen bei selbstleuchtenden Vorgängen, und die geschränkte Gesamtbildzahl in der bisher üblichen Ausführungsform.

Mit einer neuen Anordnung, die die Nachteile des letzten Punktes behebt, soll sich die vorliegende Mitteilung beschäftigen. Die Anlage umfasst 5 Reihen a 10 Funkenstrecken. Der Film auf den zugehörigen 5 Trommeln ist 25 cm breit und 1 m lang,s o dass bei 100 m/s Geschwindigkeit des Filmes bei einer Bildhöhe von 2 cm 2.500 Gesamtbilder maximal von einem Vorgang aufgenommen werden können, 5000 bei 1 cm Bildhöhe. Die Bildfrequenz kann auf 500.000 B/s bei 2 cm Bildhöhe und auf 1.000.000 B/s bei 1 cm Bildhöhe gesteigert werden. Damit ergibt sich eine ausserordentlich hohe Gesamtinformation.

High-Speed Photography of Rapid Air Currents and Shockwaves With High-Frequency High-Voltage Sparks

H. G. Patzke, Walter Thorwart and Frank Früngel, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Germany

The Bömelburg-, Weske- and Herzog method has been perfected for practical application in wind tunnel work with 8- to 20-in. sparks by a pulse transformer of novel design permitting energies up to 40 megawatts at up to 50,000 controlled 0.3 to 1 μsec discharges per second, with voltages rating up to 250 kv.

Strobokin-controlled ultra-rapid spark discharges at 5000 to 300,000/sec are fed into the primary of a special pulse transformer whose essential component is a laminated sheet metal core of hypersil sheets with hostaphane insula-

Photographie ultra-rapide de flux d'air rapides et d'ondes de choc à l'aide d'étincelles à haute tension et haute fréquence

H. G. Patzke, Walter Thorwart et Frank Früngel, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Allemagne

La méthode de Bömelburg, Weske et Herzog a été perfectionnée, en particulier pour l'application aux travaux dans des tunnels aérodynamiques, par l'utilisation d'étincelles de 20 à 50 cm de longueur produites à l'aide d'un transformateur d'impulsions de construction nouvelle, lequel admet des énergies jusqu'à 40 megawatts pour des fréquences jusqu'à 50.000 par seconde, avec des durées de 0,3 à 1 μsec par décharge; les tensions peuvent atteindre 250 kv.

Hochfrequenz-Photographie schneller Luftströmungen und Schockwellen mit Hilfe von hochfrequenten Hochspannungsfunken

H. G. Patzke, Walter Thorwart und Frank Früngel, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Deutschland

Die Bömelburg/Weske/Herzog — Methode ist besonders für Anwendung bei Arbeiten im Windtunnel vervollkommnet worden mit Funken von 20–50 cm Länge und zwar mit Hilfe eines Impuls-Transformers neuer Konstruktion, der Energien bis zu 40 Megawatt bei gesteuerten Frequenzen bis zu 50.000/s zulässt, wobei die Entladung 0,3 — 1 μs dauert, und die Spannungen bis zu 250 kv reichen.

Nach dem neuen System werden Strobokingesteuerte ultra-schnelle Funkenentladungen bei

tion. At a voltage of approximately 5 kv per turn, the laminated hypersil-sheet core is charged to magnetic saturation value in approximately 0.2 μsec. The result is a steep voltage step-up at the secondary, which at 75 turns, for example, produces a no-load voltage of 300 kv.

Due to the short spark discharge time no picture blur results even at air flow of several Machs. Though the spark's luminance is sufficient for high-speed photography, practical experience shows that its low energy does not cause thermodynamic disturbances of the observed air flow. The lowest possible spark rate where no deionization occurs is 5000/sec at 1-mm spark spacing, corresponding to an air current velocity of 5 m/sec., whereas the maximum spark rate of 300,000/sec at 10 mm from spark to spark corresponds to an air current velocity of 3 km/sec, i.e., approximately Mach 9. Also patterns of explosion and detonation shockwaves and their subsequent eddy currents can be traced by the above-outlined spark method.

Des décharges d'une fréquence de 5000 à 300.000 par seconde, fournies par le Strobokin, sont envoyées dans l'enroulement primaire d'un transformateur d'impulsions spécial, dont la partie essentielle est un noyau de fer en toles "Hyperm" avec isolement à l'hostaphane. Pour une tension d'environ 5 kv par spire, le noyau lamellé est amené à sa saturation magnétique en environ 0,2 μsec. Il en résulte une élévation très rapide de la tension au secondaire; pour 75 spires, par exemple, la tension à vide est de 300 kv.

Grace à la courte durée des étincelles, les images sont exemptes de flou, mrme pour des vitesses du flux d'air de plusieurs Mach. Bien que la brillance des étincelles soit suffisante pour la photographie ultra-rapide, l'expérience pratique a montré que leur faible énergie n'occasionne aucune perturbation thermodynamique du flux d'air observé. La cadence d'étincelles la moins élevée possible pour laquelle il ne se produit pas de désionisation est de 5000 par seconde avec une distance de 1 mm entre les étincelles, ce qui correspond à une vitesse du flux d'air de 5 m/sec. La cadence maximum de 300.000 étincelles par seconde avec une distance de 10 mm entre les étincelles correspondrait à une vitesse du flux d'air de 3 km/sec, c'est-à-dire, Mach 9. De la mrme manière, les perturbations produites dans un flux d'air par des explosions et des ondes de choc de détonations et la formation de tourbillons subséquents peuvent rtre enregistrées par la méthode décrite.

5000 — 300.000 Entladungen/s in die Primärwicklung eines speziellen Impuls-Transformators geleitet, dessen wesentlichster Bestandteil ein laminierter Eisenblechkern aus Hypermblechen mit Hostaphanisolation ist. Bei einer Spannung von ungefähr 5 kv pro Windung ist der laminierte Hypermblechkern in ungefähr 0,2 μs auf seinen magnetischen Sättigungswert aufgeladen. Das Ergebnis ist ein steiler Spannungsanstieg in der Sekundärwicklung der bei z.B. 75 Windungen eine Leerlaufspannung von 300 kv ergibt.

Wegen der kurzen Funkenentladungszeit kann kein Verschmieren der Bilder entstehen selbst bei Luftströmungen von mehreren Mach. Obwohl die Helligkeit der Funken aus reichend für Hochfrequenz-Photographie ist, hat die praktische Erfahrung gezeight, dass ihre geringe Energie keinerlie thermodynamische Störungen des beobachteten Luftstromes verursacht. Die niedrigst mögliche Funkenfolge wo keine Deionisation auftritt ist 5000 pro Sekunde bei einem Funkenabstand von 1 mm, was einer Luftströmungsgeschwindigkeit von 5 m/s entspricht, während die maximale Funkenfolge 300.000/s bei 10 mm Funkenabstand einer Luftströmungsgeschwindigkeit von 3 km/s entsprechen würde, d.h. ungefähr Mach 9. Ebenso können die Luftströmungszersetzungen von Explosionen und Detonations-Schockwellen und ihre nachfolgenden Luftverwirbelungen mit der oben erwähnten Funkenmethode aufgezeichnet werden.

A Modern Shadowgraph System for Use in High Velocity Aeroballistic Ranges

PAUL H. CORDS JR., WILLIAM R. NOYES and P. A. THURSTON, U. S. Naval Ordnance Laboratory, White Oak, Md.

An enclosed range has been constructed at the Naval Ordnance Laboratory to provide a means of securing data from missile models of large size and of hypervelocities. This range is 1000 ft in length and has a diameter of 10 ft. In order to provide a means of recording the performance of missiles while traveling the length of the range, a new shadowgraph system was designed and constructed.

Un système sciographe moderne destiné aux polygones aérobalistiques à grandes vitesses

PAUL H. CORDS, JR., WILLIAM R. NOYES et P. A. THURSTON, U.S. Naval Ordnance Laboratory, White Oak, Md.

Un polygone clos a été construit au Laboratoire d'Artillerie Navale des Etats-Unis pour fournir le moyen de recueillir les données d'observations faites pour les modèles d'engins téléguidés de grandes dimensions et d'hypervitesses. Ce polygone aérobalistique a une longueur de 1000 pieds et un diamètre de 10 pieds. Afin de pouvoir enregistrer les performances des engins pendant leur parcours dans la longueur du polygone, un nouveau système sciographe a été étudié et construit.

Eine Moderne Schattenschreiberanlage für Versuchsstätten der Hochgeschwindigkeits-Aeroballistik

PAUL H. CORDS, JR., WILLIAM R. NOYES und P. A. THURSTON, U. S. Naval Ordnance Laboratory, White Oak, Md.

Beim Naval Ordnance Laboratory wurde eine abgeschlossene Schiesstätte gebaut, um Daten über Raketenmodelle bedeutender Grösse und höchster Geschwindigkeiten zu erhalten. Diese Schiesstätte ist 1000 Fuss lang und hat einen Durchmesser von 10 Fuss. Als Mittel zur Aufnahme des Verhaltens der Geschosse während des Durchlaufens der Schiesstätte wurde eine neue Schattenschreiberanlage entworfen und gebaut.

Submicrosecond Flash Sources

HAROLD E. EDGERTON, JOHN TREDWELL and KENNETH W. COOPER, JR., Massachusetts Institute of Technology, Cambridge, Mass.

Design details are given for two submicrosecond flash sources for photography by reflected light, silhouette and schlieren techniques. The source for reflected light photography uses a "guided" air spark operated at 18 kv with 0.05 μf to produce a $\frac{1}{2}$-μsec flash with a peak light of 5-million candlepower. The flashtube, a special design, is described, together with its power supply and trigger circuit. The trigger circuit can be operated by a microphone, phototube, contactor or other electrical signal, and incorporates an adjustable time delay. Photographs taken with the unit are shown.

A small spark source capable of producing flashes of about 10 mμsec duration for silhouette and schlieren photography is described. Relative peak light output and flash duration are given as a function of pressure for air, nitrogen, oxygen, carbon dioxide, hydrogen and argon. Gap resistance is given as a function of gap length, for air.

Des sources de flash de l'ordre des submicrosecondes

HAROLD E. EDGERTON, JOHN TREDWELL et KENNETH W. COOPER, JR., Massachusetts Institute of Technology, Cambridge, Mass.

Les auteurs donnent les détails de construction de deux sources de flash de l'ordre des submicrosecondes pour la photographie par les techniques à lumière réfléchie, sciographie et schlieren. La source destinée à la photographie avec lumière réfléchie utilise une aéro-étincelle "guidée" produite à 18 kv avec 0,05 μf pour donner un éclair de $\frac{1}{2}$ de μsec d'une intensité lumineuse maximum de 5 millions de bougies. On donne une description du tube-éclair de construction spéciale, ainsi que de son système d'alimentation électrique et son circuit de déclenchement. Ce circuit déclencheur peut être commandé par microphone, phototube, contacteur ou un autre signal électrique, et comporte un retard réglable. Des photographies prises avec l'appareil sont représentées.

L'article décrit aussi une petite source d'étincelles capable de produire des flashes d'une durée d'environ 10 millimicrosecondes pour la sciographie et la photographie schlieren. Les valeurs relatives de la luminosité maximum et de la durée du flash sont indiquées en fonction de la pression pour l'air, l'azote, l'oxygène, l'anhydride carbonique, l'hydrogène et l'argon. La résistance de la distance explosive est donnée en fonction de l'écartement pour l'air.

Lichtquelle für Blitze von unter einer Mikrosekunde

HAROLD E. EDGERTON, JOHN TREDWELL und KENNETH W. COOPER, JR., Massachusetts Institute of Technology, Cambridge, Mass.

Es werden Einzelheiten zweier Apparate für Lichtblitze von unter einer Mikrosekunde gegeben, die zum Photographieren bei reflektiertem Licht sowie für Schatten-und Schlierenverfahren in Frage kommen. Für reflektiertes Licht wurde ein "geführter" Luftfunke von 18 kV mit 0,05 Mikrofarad benützt, um einen Blitz von $\frac{1}{2}$ Mikrosekunde und einer Spitzen-Lichtstärke von 5 Millionen Kerzen zu erzielen. Es wird die Blitzröhre, die von besonderer Ausführung ist, beschrieben ebenso wie ihre Stromversorgung und der auslösende Stromkreis. Letzterer kann sowohl durch ein Mikrophon wie auch durch Photoröhre, Schaltschütz oder ein anderes elektrisches Zeichen angeregt werden und enthält eine einstellbare Verzögerung. Es werden Aufnahmen gezeigt, die mit dem Apparat gemacht wurden.

Es wird eine kleine Einrichtung beschrieben, welche imstande ist, Funken von einer Dauer von ungefähr 10 Millimikrosekunden für Schatten- und Schlierenphotographie zu liefern. Die relative Lichtleistung sowie die Blitzdauer werden als abhängig vom Druck von Luft, Stickstoff, Sauerstoff, Kohlensäure, Wasserstoff und Argon angeführt. Der Spaltwiderstand ist für Luft und mit der Spaltlänge als variablen angegeben.

A High-Intensity Rectangular-Pulse Light Source for High-Speed Photography

T. Marshall, B. J. Crapo and L. I. Hill,
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Silver Spring, Md.

Workers in many fields who use high-speed photographic techniques have constantly searched for higher-intensity light sources and better means of shuttering the light. A method has been devised for constructing a self-shuttering light source of very high intensity. The principle involved is the use of an artificial transmission line which is designed to match the impedance of a terminating discharge tube. Once triggered, the transmission line maintains the voltage across the discharge tube at a constant value for a time which depends on the design of the line and the number of "L" sections in the line. At the end of this design time the voltage across the discharge tube drops abruptly to zero. The result is a light pulse which has a rectangular profile.

Four sources have been constructed and are operating very successfully in conjunction with several continuous-writing cameras. These sources give light pulses of from 100 μsec to 3 msec in duration. The deviation away from an ideal rectangular pulse for the 3-msec line is less than 10%, while the deviation for the 100-μsec line is less than 1%. These deviations are due to resistive losses present in the line.

Une source lumineuse de haute intensité à pulsations de profil rectangulaire pour la photographie à grande vitesse

T. Marshall, B. J. Crapo et L. L. Hill,
U.S. Naval Ordnance Laboratory,
Silver Spring, Md.

Dans de nombreux domaines ou l'on utilise les techniques photographiques à grande vitesse, on cherchait depuis longtemps à réaliser des sources lumineuses de plus grande intensité et des systèmes plus efficaces pour l'obturation de la lumière. On a maintenant réussi à construire une source lumineuse auto-obturatrice de très haute intensité. Le principe mis en jeu est l'emploi d'une ligne de transmission artificielle qui est conçue pour correspondre à l'impédance d'un tube de décharge terminal. Une fois déclenchée, la ligne de transmission maintient le voltage qui traverse le tube de décharge à une valeur constante pendant un temps qui dépend de la construction de la ligne et du nombre de sections en "L" de cette ligne. Une fois ce temps écoulé, le voltage qui traverse le tube de décharge tombe brusquement à zéro. Il en résulte une pulsation lumineuse qui a un profil rectangulaire.

Quatre de ces sources ont été construites et fonctionnent avec des résultats trés satisfaisants en combinaison avec plusieurs caméras à enregistrement continu. Ces sources produisent des pulsations lumineuses d'une durée de 100 μsec à 3 msec. L'écart par rapport à une pulsation idéale de profil rectangulaire est inférieur à 10% pour la ligne de 3 msec, alors que la déviation est de moins de 1% pour la ligne de 100 μsec. Ces déviations sont dues à la présence de pertes de résistivité dans la ligne.

Eine Hochintensitäts-Lichtquelle mit rechteckigem Impuls für Hochgeschwindigkeits-Photographie

T. Marshall, B. J. Crapo und L. L. Hill,
U. S. Naval Ordnance Laboratory,
Silver Spring, Md.

Forscher auf vielen Gebieten, die Hochgeschwindigkeits- Photographie anwenden, haben schon immer nach besseren Lichtquellen und besseren Verschlussmöglichkeiten gesucht. Es wurde nun eine Konstruktionsmethode für eine selbstschliessende Lichtquelle sehr hoher Intensität gefunden. Das in Frage kommende Prinzip beruht auf dem Gebrauch einer künstlichen Ubertragungsleitung, die so angelegt ist, dass sie dem Widerstand einer Endentladungsröhre angepasst ist. Sobald sie angeregt wird hält die Ubertragungsleitung die Spannung über die Entladungsröhre konstant und zwar für eine Zeitdauer, welche von der Anlage der Leitung und der Anzahl der "L"-Abschnitte in derselben abhängt. Am Ende dieser im Entwurf vorgesehenen Zeit fällt die Spannung über die Entladungsröhre plötzlich auf Null herab. Dadurch entsteht ein Lichtimpuls von rechteckigem Profil.

Es wurden vier solcher Lampen gebaut und sie arbeiten mit sehr gutem Erfolg in Verbindung mit mehreren kontinuierlich registrierenden Kameras. Sie geben Lichtimpulse einer Dauer von 100 Mikrosekunden bis zu 3 Millisekunden. Die Abweichung von der idealen rechteckigen Impulsform beträgt weniger als 10% für die 3 Millisekunden-Leitung während sie bei der 100 Mikrosekunden-Leitung weniger als 1% ausmacht. Diese Abweichungen sind die Folge von in der Leitung vorhandenen Widerstandsverlusten.

MONDAY 4:00 P.M. SESSION: Applications — Miscellaneous

Application of High-Speed Photography in Nuclear Reactor Development

DANIEL S. GIROUX and GEORGE W. LINDHOLM, Argonne National Laboratory, Chicago

Examples of high-speed motion pictures obtained as part of the nuclear reactor engineering studies at Argonne National Laboratory are presented in a 16mm film. These high-speed records have contributed to the understanding of many factors in the design and operation of nuclear reactors and related systems. Subject material for the high-speed studies include uranium-chemical reactions, heat-transfer studies, mechanical component analysis, sodium water reactions, fuel element fabrication, and reactor power transients. A series of power transients culminate in the deliberate self-destruction of an early nuclear reactor.

L'application de la photographie à grande vitesse dans la réalisation des réacteurs nucléaires

DANIEL S. GIROUX et GEORGE W. LINDHOLM, Argonne National Laboratory, Chicago

Des exemples de photos cinématographiques à grande vitesse obtenues au cours d'études techniques de réacteurs nucléaires au Laboratoire National Argonne sont présentés sous forme d'un film de 16mm. Ces enregistrements photographiques à grande vitesse ont contribué à mieux comprendre les nombreux facteurs qui entrent en jeu dans la construction et le fonctionnement des réacteurs nucléaires et des systèmes qui s'y rattachent. Les études de grande vitesse en question ont porté notamment sur les réactions des produits chimiques de l'uranium, les études de transmission de la chaleur, l'analyse des éléments mécaniques, les réactions entre le sodium et l'eau, la fabrication des éléments combustibles et les phases transitoires d'énergie de réacteurs. Une série de phases transitoires d'énergie aboutit à l'auto-destruction intentionnelle d'un réacteur nucléaire de type ancien.

Die Anwendung der Hochgeschwindigkeits-Photographie bei der Entwicklung von Kernreaktoren

DANIEL S. GIROUX und GEORGE W. LINDHOLM, Argonne National Laboratory, Chicago

In einem 16 mm Film werden kinematographische Hochgeschwindigkeitsaufnahmen gezeigt, die als Teil der technischen Untersuchungen über Kernreaktoren im Argonne National Laboratory erzielt wurden. Diese Hochgeschwindigkeits-Aufnahmen haben zum Verständnis vieler Faktoren betreffend Konstruktion und Betrieb von Kernreaktoren und ähnlichen Anlagen beigetragen. Die Hochgeschwindigkeits-Studien behandeln Uran-chemische Reaktionen, Studien der Hitzeübertragung, Analyse mechanischer Bestandteile, Natrium-Wasser Reaktionen, Erzeugung von Kern-Heizelementen und Reaktor-Kraftausgleiche. Eine Reihe von Kraftausgleichen zeigt als Höhepunkt die absichtliche Selbstzerstörung eines alten Kernreaktors.

The Use of High-Speed Photography and Photoelastic Coatings for the Determination of Dynamic Strains

C. A. COLE, JR., and JOHN F. QUINLAN, U. S. Naval Medical Field Research Laboratory, Marine Corps Base, Camp Lejeune, N. C.; and FELIX ZANDMAN, Instruments Division, The Budd Company, Phoenixville, Pa.

High-speed photography and photoelasticity have been widely used to determine dynamic strains in transparent plastic models subjected to shocks, vibrations, etc. The recent development of a photoelastic-coating technique has opened new horizons for investigation of dynamic strain phenomena in opaque structural parts. The part is coated with photoelastic plastic film and statically or dynamically loaded. Strains are transmitted from the surface of the part to the plastic coating. The interference pattern obtained when the plastic is illuminated with polarized light is interpreted by classical photoelastic methods. The pattern is recorded by a camera whose photographic rate is chosen as a function of velocity of the dynamic strain phenomena.

This paper describes color and black-and-white reflected-light photography accomplished with a 48,000-to-1,200,000 frame/sec framing camera using argon flash bombs or electronic flash. Photography of materials coated with photoelastic plastic is emphasized. The dynamic strain distribution due to wave propagation is investigated. The effect of plastic thickness and time lag due to the difference of modulus of elasticity and density of the plastic, as compared to the underlying material, is discussed. An attempt is made to obtain quantitative data from the photoelastic patterns observed.

L'emploi de la photographie à grande vitesse et des revêtements photo-élastiques pour la détermination des tensions dynamiques

C. A. COLE, JR. et JOHN F. QUINLAN, U.S. Naval Medical Field Research, Marine Corps Base, Camp Lejeune, N.C.; et Felix Zandman, Instruments Div., The Budd Company, Phoenixville, Pa.

La photographie à grande vitesse et la photo-élasticité ont été employées sur une grande échelle pour déterminer les tensions dynamiques dans les modèles en matière plastique transparente soumis à des chocs, des vibrations, etc. La mise au point récente d'une technique à revêtement photo-élastique a ouvert de nouveaux horizons pour l'étude des phénomènes à tensions dynamiques dans les pièces de construction opaques. On revêt la pièce d'une pellicule plastique photo-élastique et on la charge statiquement ou dynamiquement. Les tensions se transmettent de la surface de la pièce au revêtement plastique. Le dessin d'interférence obtenu quand on éclaire la matière plastique avec une lumière polarisée est interprété par les méthodes photo-élastiques classiques. Ce dessin est enregistré par une caméra dont la cadence photographique est choisie en fonction de la vitesse du phénomène des tensions dynamiques.

Le présent mémoire décrit la photographie par lumière réfléchie, en couleur ou en blanc et noir, obtenue avec une caméra à cadence de 48.000 à 1.200.000 images/s qui utilise des bombes-flash à l'argon ou un flash électronique. Les auteurs donnent une grande part à la photographie des matières ayant reçu un revêtement plastique photo-élastique. Ils étudient la répartition des tensions dynamiques dues à la propagation des ondes. Ils examinent l'effet de l'épaisseur du plastique et du décalage de temps dû à la différence de module d'élasticité et de densité de la matière plastique par rapport à ceux de la matière sous-jacente. Une tentative est faite pour tirer des données quantitatives des dessins photo-élastiques observés.

Die Anwendung der Hochgeschwindigkeits-Photographie und von photoelastischen Schichten zur Bestimmung dynamischer Spannungen

C. A. COLE, JR., und JOHN F. QUINLAN, U.S. Naval Medical Field Research Laboratory, Marine Corps Base, Camp Lejeune, N.C.; und FELIX ZANDMAN, Instruments Division, The Budd Company, Phoenixville, Pa.

Hochgeschwindigkeits-Photographie und Photoelastizität wurden bereits vielfach dazu gebraucht dynamische Spannungen in transparenten Kunststoffmodellen zu bestimmen, die Stössen, Vibrationen usw. ausgesetzt wurden. Die jüngste Ausarbeitung einer Beschichtungsmethode mit photoelastischen Stoffen hat der Untersuchung von dynamischen Spannungserscheinungen in undurchsichtigen Bauteilen neue Gebiete eröffnet. Der Teil wird mit einer photoelastischen Kunststoffschicht überzogen und statisch oder dynamisch belastet. Die Spannungen werden von der Oberfläche des Teiles zur Kunststoffschicht weitergeleitet. Das Interferenzbild, welches man erhält sobald man den Kunststoff mit polarisiertem Licht beleuchtet, wird nach bekannten photoelastischen Methoden ausgelegt. Das Interferenzbild wird mittels einer Kamera aufgenommen, deren Bildfrequenz als Funktion der Geschwindigkeit der dynamischen Spannungserscheinungen gewählt wurde.

Der Artikel beschreibt Farb- und Schwarz-Weiss-Photographie im reflektierten Licht, ausgeführt mit einer Bildreihenkamera für eine Frequenz von 48.000 bis 1.200.000 Aufnahmen/s unter Benützung von Argon-Blitzbomben oder Elektronenblitz. Es wird das Photographieren von Materialien, die mit photoelastischem Kunststoff beschichtet wurden, hervorgehoben. Es wird auch die dynamische Spannungsverteilung infolge Wellenfortpflanzung untersucht. Weiters wird der Einfluss der Kunststoffdicke und die Verzögerung erörtert, die auf die Differenz des Elastizitätsmoduls und die Dichte des Kunststoffs verglichen mit dem Grundmaterial zurückzuführen ist. Es wird versucht von den beobachteten photoelastischen Interferenzbildern quantitative Daten abzuleiten.

Underwater High-Speed Photography

JOHN V. PFLAUM, U. S. Navy Electronics Laboratory, San Diego, Calif.

Experiments conducted by the U.S. Navy Electronics Laboratory required high-speed motion-

La photographie sous-marine à grande vitesse

JOHN V. PFLAUM, U.S. Navy Electronics Laboratory, San Diego, Californie

Des expériences entreprises par le Laboratoire

Unterwasser-Hochgeschwindigkeits-Photographie

JOHN V. PFLAUM, U.S. Navy Electronics Laboratory, San Diego, Kalifornien

Experimente, die vom U.S. Navy Electronics

picture photography of pneumatic and spark sound producing devices from 100- to 300-ft water depths. Film speeds of 1500 to 3000 frames/sec were necessary to observe and evaluate equipment performance. Two Eastman high-speed cameras and light sources were enclosed in special underwater cases designed to withstand pressures equal to a 700-ft water depth.

The use of SCUBA divers for servicing the equipment was not feasible due to the operating depths; therefore, both the devices undergoing tests and the photographic equipment were mounted on a semiportable rig to be lowered into the water after having been properly aligned on the surface. Cable lengths, voltage drops, synchronizing camera and event, and field processing all posed problems to be overcome. Usable data were obtained on both Eastman Tri-X Panchromatic and Super Anscochrome films.

Electronique de la Marine Américaine ont nécessité la photographie cinématographique à grande vitesse d'appareils producteurs de sons de type pneumatique ou à étincelles depuis des profondeurs sous-marines de 100 à 300 pieds. Des vitesses de film de 1500 à 3000 images/s ont été nécessaires pour observer et évaluer le fonctionnement de l'équipement. Deux caméras à grande vitesse et sources lumineuses ont été enfermées dans des coffres sous-marins de type spécial conçus pour soutenir des pressions équivalentes à une profondeur d'leau de 700 pieds.

L'emploi de scaphandriers SCUBA pour le dépannage de l'équipement n'était pas possible à cause des grandes profondeurs opératoires; on a donc dû monter tant les appareils soumis aux essais que l'équipement photographique sur une monture demi-portative étudice pour être descendue dans l'eau après avoir étc alignée correctement à la surface. Il a fallu aussi résoudre les problèmes spéciaux posés par la longueur des câbles, les chutes de voltage, la synchronisation de la caméra et du processus à photographier, et le traitement des films sur les lieux. On a obtenu des renseignements utilisables tant sur Tri-X Panchromatic Eastman que sur Super Anscochrome.

Laboratory durchgeführt wurden, erforderten die Hochgeschwindigkeits-Kinematographie von schallerzeugenden Geräten (pneumatisch und mittels Funken arbeitend) in Tiefen von 100 bis 300 Fuss unter der Wasseroberfläche. Um das Funktionieren der Geräte beobachten und bewerten zu können waren Bildfrequenzen von 1500 bis 3.000 Aufnahmen/s notwendig. Zwei Eastman Hochgeschwindigkeitskameras und ihre Lichtquellen wurden in besonderen Unterwassergehäusen untergebracht, die für Drücke entsprechend einer Wassertiefe von 700 Fuss gebaut waren.

Wegen der Tiefe war es nicht möglich SCUBA-Taucher (Schwimmtaucher mit Sauerstoffgerät) zur Bedienung der Ausrüstung einzusetzen; es mussten daher sowohl die zu untersuchenden Geräte wie auch die photographische Ausrüstung an ein halbtragbares Gestell montiert und, nachdem alles gut ausgerichtet war, in die Tiefe versenkt werden. Manche Probleme mussten überkommen werden: Länge der Kabel, Spannungsabfälle, synchronisieren der Kamera und des Vorgangs und Ausarbeiten der Filme an Ort und Stelle. Sowohl auf Eastman Tri-X Panchromatic und Super Anscochrome Filmen wurden brauchbare Daten erzielt.

High-Speed Photographic Studies of Electrically Exploded Metal Films and Wires

L. Zernow, G. Woffinden and F. Wright, Jr., Aerojet-General Corp., Downey, Calif.

The most recent work on the cinemicroscopy of electrically exploded wires has been concerned with the investigation of the effect of impurities in the wire upon the observed behavior when the wire is exploded. The bubble formation phenomenon which leads to the formation of transverse striations has been shown to be drastically modified by the presence of a small amount of thorium oxide in the tungsten wire. Animated cinemicroscopic observations with the high-speed framing camera at 25× magnification illustrate this effect.

The behavior of an electrical discharge through a thin metallic film can be followed both by electrical monitoring and by photographic observation with a high-speed framing camera. Two types of optical phenomena are observed. The first occurs quickly coinciding with an initial current pulse to be related to the conduction process through the film. The second, a surface phenomenon, yields a second current pulse when the voltage across the electrodes exceeds a critical value. These phenomena are illustrated with typical observations. Interpretations are suggested.

Etudes photographiques à grande vitesse des fils et pellicules métalliques explosés électriquement

L. Zernow, G. Woffinden et. F. Wright, Jr., Aerojet-General Corp., Downey, Californie

Les travaux les plus récents effectués en cinémicroscopie des fils métalliques explosés électriquement ont eu pour objet d'étudier l'effet des impuretés contenues dans le fil sur le comportement observé lors de l'explosion du fil. On a démotré que le phénomène de la formation de bulles, qui occasionne la formation de striations transversales, est modifié profondément par la présence d'une faible quantité d'oxyde de thorium dans le fil de tungstène. Cet effet est illustré par des observations cinémicroscopiques animées qui ont été obtenues au moyen de la caméra multi-images à grande vitesse avec amplification de 25 fois.

On peut suivre le comportement d'une décharge électrique à travers une mince pellicule métallique d'une part à l'aide du contrôle électrique et d'autre part au moyen de l'observation photographique avec une caméra à cadence d'images élevée. On a observé deux genres de phénomènes optiques. Le premier de ces phénomènes se produit rapidement, coïncidant avec une pulsation initiale de courant en relation étroite avec le processus de conduction à travers la pellicule. Le deuxième, qui est un phénomène de surface, engendre une seconde pulsation de courant lorsque le voltage entre les électrodes dépasse une certaine valeur critique. Ces phénomènes sont illustrés par des observations typiques. Les auteurs suggèrent des interprétations.

Untersuchungen elektrisch explodierter Metallschichten und -Drähte durch Hochgeschwindigkeitsphotographie

L. Zernow, G. Woffinden und F. Wright Jr., Aerojet-General Corp., Downey, Kalifornien

Die jüngsten Arbeiten betreffend die Kine-Mikroskopie elektrisch explodierter Drähte betrafen die Untersuchung der Einwirkung von Verunreinigungen im Draht auf das beobachtete Verhalten beim Explodieren desselben. Die Erscheinung der Blasenbildung das zur Bildung von Transvers-Schlieren führt wurde durch das Vorhandensein einer kleinen Menge von Thoriumoxyd im Wolframdraht bedeutend herabgesetzt. Dieser Effekt wird durch kinemikroskopische Beobachtungen mit der Hochgeschwindigkeits-Bildreihenkamera bei 25facher Vergrösserung veranschaulicht.

Das Verhalten einer elektrischen Entladung durch eine dünne Metallschicht lässt sich sowohl durch elektrische Registrierung wie durch photographische Beobachtung mit einer Hochgeschwindigkeits-Bildreihenkamera verfolgen. Es wurden zwei Typen optischer Phänomene beobachtet. Das erste spielt sich schnell ab und fällt mit einem anfänglichen Stromimpuls zusammen, der mit dem Leitungsvorgang durch die Schicht zu tun haben mag. Die zweite Erscheinung, ein Oberflächenphänomen, ergibt einen zweiten Stromimpuls sobald die Spannung über die Elektroden einen kritischen Wert übersteigt. Diese Erscheinungen werden durch typische Beobachtungen illustriert und Erklärungen angedeutet.

Comments on Recent Innovations in Rotating-Prism Cameras

John H. Waddell, John H. Waddell Co., Syosset, N. Y.

(*The presentation will include a summary of late developments.*)

Observations sur des développements récents à l'égard des caméras à prismes tournants

John H. Waddell, John H. Waddell Co., Syosset, N. Y.

Neue Entwicklungen in Bezug auf Kameras mit rotierenden Prismen

John H. Waddell, John H. Waddell Co., Syosset, N. Y.

—— MONDAY 8:00 P.M. CONGRESS OPENING: Addresses of welcome

Guest Speaker: Crawford H. Greenewalt, President, E. I. du Pont de Nemours & Co.

9:05 P.M. Reception and Cocktails

OCTOBER 18 — TUESDAY 9:00 A.M. SESSION: Electric and Electronic Shutters .....

Image-Converter Systems With Fast Image Group Repetition Rates

ROBERT W. KING, and JOHN H. HETT, Hett Associates, Inc., Cresskill, N. J.

Three different types of image-converter cameras have been designed over the past several years with various characteristics but all emphasizing fast exposure rates. The three cameras all use the Mullard converter tube type 1201 with the short-persistence blue phosphor for photographic recording. The first camera produces a sequence of six rectangular images having an aspect ratio of about 5:1. The exposure time of 0.4 μsec was used and a fixed exposure interval of 5 μsec. This camera takes one group of six exposures at a time with a relatively long recovery time.

The second camera has considerably advanced characteristics. This camera makes six exposures on a single frame at rates varying from 2×10^6 to 2×10^4 exposures/sec. The frame rate extends from zero to 5000, the upper limit depending on exposure rates. Exposure durations have these values: 0.1, 0.3, 1.0, 3.0 and 10.0 μsec. Repetition rate and exposure time duty cycle may not exceed 20%. Deflection of the image takes place on both axes producing two rows of three groups each.

The third and latest camera design is similar to the second, having exposures of 0.1, 0.3, 1.0, 3.0 and 10 μsec and corresponding exposure rates of 2×10^6 and 2×10^4 exposures/sec. The sequence pulse and shutter pulse generator is very similar; however, the sweep is wholly on one axis and therefore similar to the first camera described. The mechanism of sweep generation is quite different, however, the basic sweep form being generated by a diode pump counting circuit. Displays of 4 or 8 images may be selected.

Des systèmes à convertisseur d'images No. 64 à cadences rapides de répétition de groupes-images

ROBERT W. KING et JOHN H. HETT, Hett Associates, Inc., Cresskill, N.J.

Trois types différents d'appareils de prise de vues à convertisseur d'images ont été réalisés au cours de ces dernières années; bien qu'ils aient des caractéristiques variées, ils se signalent tous par des cadences d'exposition rapides. Ces trois appareils utilisent tous le tube convertisseur Mullard de type 1201 avec phosphore bleu de courte persistance pour l'enregistrement photographique. Le premier de ces appareils produit une série de six images rectangulaires qui ont un rapport d'allongement d'environ 5:1. Le temps d'exposition de 0,4 μsec et l'intervalle d'exposition de 5 μsec sont fixes. Cet appareil prend un groupe de six clichés à la fois avec un temps de rétablissement relativement long.

Le deuxième des appareils a des caractéristiques très poussées. Il donne six expositions sur un même cliché à des cadences qui varient de 2×10^6 à 2×10^4 expositions par seconde. La cadence d'images va de zéro à 5000, la limite supérieure dépendant des cadences d'exposition. Les temps d'exposition ont les valeurs suivantes: 0,1, 0,3, 1,0, 3,0 et 10,0 μsec. Le cycle opératoire des cadences de répétition et des temps d'exposition ne peut pas dépasser 20%. Le décalage de l'image a lieu sur les deux axes, ce qui a pour effet de produire deux rangées de chacune trois groupes.

Le troisième des appareils, qui est le plus récent, est analogue au deuxième; il a des temps d'exposition de 0,1, 0,3, 1,0, 3,0 et 10 μsec et des cadences d'exposition correspondantes de 2×10^6 et 2×10^4 expositions par seconde. Le générateur de pulsation de série et de pulsation d'obturateur est très similaire; toutefois, le mouvement circulaire est entièrement sur un même axe et partant semblable à celui du premier appareil décrit. La différence réside dans le mécanisme d'engendrement du mouvement circulaire car ici la forme de base de ce mouvement est produite par un circuit compteur avec diode à action de pompage. On a le choix de montures à 4 ou à 8 images.

Bildwandlersysteme mit rascher Bildgruppenwiederholung

ROBERT W. KING und JOHN H. HETT, Hett Associates, Inc., Cresskill, N. J.

Während der allerletzten Jahre wurden drei verschiedene Arten von Bildwandlerkameras entworfen, die zwar verschiedene Charakteristiken aufweisen, die aber alle eine schnelle Belichtungsfolge als Hauptmerkmal haben. Alle drei Kameras arbeiten mit der Mullard Wandlerröhre Mod. 1201 mit dem blauen Phosphor kurzer Beharrlichkeit für photographische Aufzeichnung. Die erste Kamera liefert eine Reihe von 6 rechteckigen Bildern im Formatverhältnis von ungefähr 5:1. Die Belichtungszeit von 0,4 Mikrosekunden und der Belichtungsintervall von 5 Mikrosekunden sind unveränderlich. Diese Kamera nimmt eine Gruppe von 6 Aufnahmen auf einmal auf und hat eine verhältnismässig lange Rückführungszeit.

Die zweite Kamera ist bedeutend moderner; sie nimmt sechs Aufnahmen auf ein einziges Bild mit Geschwindigkeiten, die sich zwischen 2×10^6 und 2×10^4 Aufnahmen/s bewegen. Die Bildgeschwindigkeit ist von 0 bis zu 5000, wobei die obere Grenze von den Belichtungsgeschwindigkeiten abhängt. Die Belichtungszeiten zeigen die folgenden Werte: 0,1; 0,3; 1,0; 3,0 und 10,0 Mikrosekunden. Wiederholungsgeschwindigkeiten und Belichtungszeit-Arbeitszyklus dürfen 20% nicht überschreiten. Die Ablenkung des Bildes erfolgt an beiden Achsen und ergibt zwei Reihen von je drei Gruppen.

Die dritte und neueste Kamera-Bauart ist der zweiten ähnlich und hat Belichtungszeiten von 0,1; 0,3, 1,0; 3,0 und 10 Mikrosekunden und dementsprechend Aufnahmefolgen von 2×10^6 und 2×10^4 Aufrahme/s. Der Impulsgenerator für den Sequenz-Impuls und den Verschluss-Impuls ist sehr ähnlich. Das Absuchen jedoch geschieht vollkommen einachsig und daher ähnlich mit der erstbeschriebenen Kamera. Der Mechanismus für die Absuchbewegung ist jedoch ganz verschieden und die grundlegende Absuchform wird durch einen Zählstromkreis mit Diodenpumpe geschaffen. Es können nach Wahl 4 oder 8 Bilder gezeigt werden.

Development of a Photo-Electronic Shutter Tube

L. MANDEL, Imperial College of Science and Technology, University of London, England

A photoelectronic image tube usable as a high-speed shutter is being developed. The tube is a magnetically focused image intensifier, in which the photoelectron beam is made to pass through two metal meshes mounted a few centimeters from the photocathode. The first mesh acts as a control grid while the second one serves as an auxiliary electrode. Its introduction increases the control sensitivity and makes the electron focus less dependent on the control mesh potential. Shutter tubes having an on-off control voltage range of about 3 volts and a resolution of 15–20 line pairs per mm have been made. The loss of electron current due to the meshes is less than 20%. Curves are presented showing the electron penetration under various conditions of cut-off.

Développement d'un tube obturateur photo-électronique

L. MANDEL, Imperial College of Science and Technology, University of London, Angleterre

On est en train de développer un tube image photo-électronique qui peut s'employer comme obturateur à grande vitesse. Le tube est un intensificateur d'image avec dispositif magnétique de mise au point dans lequel le rayon photo-électronique passe à travers deux mailles en métal montées à quelques centimètres de la photo-cathode. La première maille remplit la fonction d'une grille de contrôle tandis que la deuxième sert comme électrode auxiliaire. Son emploi augmente la sensibilité de contrôle et rend la mise au point des électrons moins dépendante du potentiel de la maille de contrôle. Des tubes obturateurs ont été construits ayant une rangée de voltage de contrôle d'environ 3 v et une résolution de 15–20 lignes-paires/mm. La perte d'électrons à cause des mailles est moins de 20%. Des courbes démontrent la pénétration des électrons sous des conditions variées de coupage.

Entwicklung einer photoelektronischen Verschlussröhre

L. MANDEL, Imperial College of Science and Technology, University of London, England

Eine als Hochgeschwindigkeitverschluss verwendbare photoelektronische Bildröhre wird entwickelt. Die Röhre ist ein magnetisch eingestellter Bildverstärker, worin der photoelektronische Strahl durch zwei Metallmaschen geführt wird, die ein Paar Zentimeter von der Photo-Kathode angebracht sind. Die erste Masche dient als Kontrollgitter während die zweite dient als Hilfselektrode. Ihr Gebrauch vergrössert die Empfindlichkeit der Kontrolle und ermöglicht, dass der Elektron-Fokus weniger von dem Potential der Kontrollmasche abhängt. Verschlussröhren sind schon angefertigt, die einen Kontrollspannungsbereich von ungefähr 3 v und ein Auflosungsvermögen von 15–20 Linienpaaren/mm besitzen. Der Verlust an Elektronstrom durch die Maschen ist weniger als 20%. Kurven sind beigefügt, die die Penetration der Elektronen unter verschiedenen Sperrbereichbedingungen vorzeigen.

The Astracon Tube and Its Application To High-Speed Photography

A. E. Anderson and G. W. Goetze, Westinghouse Research Laboratories, Pittsburgh, Pa.

In high-speed and ultra-high-speed photography, cameras utilizing single-stage electronic image-converter tubes have proved to be very useful. These electronic cameras suffer, in general, from the disadvantage of small light gain, so that intense illumination of the object is required. The use of a multistage image intensifier tube, such as the Astracon, avoids this difficulty.

A high-speed camera for "ultimate light gain," employing two Astracon tubes, has been built. With this camera it is possible to record single photoelectron events on photographic film. The general performance of this camera is discussed, as well as more specific applications of the Astracon tube in high-speed and ultra-high-speed photography at extremely low light levels.

Le tube Astracon et son application en photographie à grande vitesse

A. E. Anderson et G. W. Goetze, Westinghouse Research Laboratories, Pittsburgh, Pa.

Dans le domaine de la photographie à grande vitesse et à ultra-grande vitesse, les appareils de prise de vues qui utilisent des tubes électroniques mono-étage convertisseurs d'images se sont avérés très utiles. Toutefois, ces appareils photographiques de type électronique avaient en général l'inconvénient du'n faible rapport lumineux, ce qui obligeait à éclairer fortement l'objet à photographier. L'emploi d'un tube intensificateur d'images de type multi-étage, tel que le tube Astracon, remédie à cette difficulté.

On a réalisé un appareil de prise de vues à grande vitesse pour un "rapport lumineux maximum" qui utilise deux tubes Astracon. Il est possible, au moyen de cet appareil, d'enregistrer des processus isolés de photo-électrons sur pellicule photographique. Les auteurs décrivent le fonctionnement général de cet appareil, ainsi que des applications particulières du tube Astracon en photographie à grande et ultra-grande vitesse à des niveaux de lumière extrêmement bas.

Die Astracon-Röhre und ihre Anwendung in der Hochgeschwindigkeitsphotographie

A. E. Anderson und G. W. Goetze, Westinghouse Research Laboratories, Pittsburgh, Pa.

In der Hochgeschwindigkeits- und Höchstgeschwindigkeits- Photographie haben sich Kameras mit einstufigen elektronischen Bildwandlerröhren als sehr nützlich erwiesen. Diese elektronischen Kameras haben gewöhnlich den Nachteil geringer Lichtstärke, so dass eine intensive Beleuchtung des Objekts erforderlich ist. Durch den Gebrauch einer mehrstufigen Verstärkerröhre wie der Astracon lässt sich diese Schwierigkeit vermeiden.

Es wurde bereits eine Hochgeschwindigkeits-Kamera für "grösste Lichtstärke" gebaut, die zwei Astracon-Röhren anwendet. Mit dieser Kamera ist es möglich einzelne Photoelektron-Erscheinungen im photographischen Film festzuhalten. Der Artikel behandelt die allgemeine Leistung der Kamera sowie andere mehr spezielle Anwendungen der Astracon-Röhre in der Hoch- und Höchstgeschwindigkeits-Photographie bei einem ausserordentlich niedrigen Lichtpegel.

A Kerr Cell Camera With Synchronized Light Source for Millimicrosecond Reflected Light Photography

George A. Theophanis, Avco Research and Advanced Development Div., Wilmington, Mass.

Certain events which can be studied photographically have associated with them a high degree of self-luminosity. To study the surface phenomena of these events, a high-resolution, 50 mμsec Kerr cell camera and synchronized light source have been developed. A three-polarizer Kerr cell, having an optical transmission ratio of better than 10^6:1, is employed to prevent undesired exposure of the film due to the relatively long duration light from the self-luminosity which would bleed through a standard two-polarizer cell when closed. The cell is activated by means of a transmission line pulse generator capable of producing a 60,000-v square-wave pulse.

The light source consists of three commercial xenon-filled flashtubes which are triggered by means of a hydrogen thyratron pulser. A transmission line network is incorporated into the flashtube pulser to produce a high-voltage synchronizing pulse when the flashtubes are ignited. This pulse is applied via a length of delay cable to the trigger electrode of the spark-gap switch which activates the Kerr cell shutter. Synchronization is accomplished with an accuracy of 5 mμsec. The camera has been used to photograph the early stages of electrically exploded metal foils, and hypervelocity impacts in a ballistics range.

Un appareil de prise de vues à élément Kerr avec source lumineuse synchronisée pour la photographie à lumière réfléchie de l'ordre des millimicrosecondes

George A. Theophanis, Avco Research and Advanced Development Div., Wilmington, Mass.

Certains processus susceptibles d'être étudiés photographiquement sont associés à un haut degré d'auto-luminosité. Afin d'étudier les phénomènes de surface de ces processus, on a réalisé un appareil de prise de vues à élément Kerr de 50 mμsec à haute résolution, ainsi qu'une source de lumière synchronisée. On utilise un élément Kerr à trois polariseurs, dont le rapport de transmission optique est supérieur à 10^6:1, pour éviter toute exposition excessive de la pellicule par suite de la lumière de durée relativement longue provenant de l'auto-luminosité qui s'infiltrerait lors de la fermeture d'un élément à deux polariseurs de type ordinaire. L'élément est excité au moyen d'un générateur de pulsation de ligne de transmission capable de produire une pulsation à ondes de profil carré de 60.000 v.

La source lumineuse consiste en trois tubes-éclair remplis de xénon de type commercial qui sont amorcés au moyen d'un pulsateur thyatron à hydrogène. Un réseau de ligne de transmission est incorporé au pulsateur du tube-éclair afin de produire une pulsation synchronisante de haut voltage quand les tubes-éclair sont allumés. Cette pulsation est appliquée par l'intermédiaire d'une longueur de câble à retard à l'électrode de déclenchement du commutateur de distance explosive qui actionne l'obturateur de l'élément Kerr. La synchronisation est accomplie avec une précision de 5 mμsec. L'appareil de prise de vues a été employé pour photographier les premières phases de feuilles métalliques explosées électriquement, ainsi que les chocs aux hypervitesses dans un polygone balistique.

Eine Kerrzellen-Kamera mit Synchronisierter Lichtquelle für die Millimikrosekunden-Photographie bei Reflektiertem Licht

George A. Theophanis, Avco Research and Advanced Development Div., Wilmington, Mass.

Gewisse Vorgänge, welche sich photographisch untersuchen lassen, besitzen einen hohen Grad eigener Lumineszenz. Um die sich an der Oberfläche zeigenden Erscheinungen solcher Vorgänge studieren zu können wurde eine Kamera entwickelt, die ein hohes Auflösevermögen zeigt und mit einer Kerrzelle von 50 Millimikrosekunden versehen ist und zu der eine synchronisierte Lichtquelle gehört. Infolge der verhältnismässig langen Dauer würde Licht der Eigenlumineszenz durch eine gewöhnliche, doppelt polarisierte Kerrzelle dringen und eine unerwünschte Belichtung des Films verursachen weshalb eine dreifach polarisierte Kerrzelle verwendet wird, die ein optisches Durchlassverhältnis von mehr als 10^6:1 besitzt. Die Zelle wird durch einen Ubertragungsleitung- Impulsgenerator aktiviert, der imstande ist einen 60.000 V Rechteckwellen-Impuls zu liefern.

Die Lichtquelle besteht aus drei handelsüblichen mit Xenon gefüllten Blitzröhren, welche durch einen Wasserstoff-Thyatron Impulsgeber aktiviert werden. In den Impulsgeber der Blitzröhre wurde ein Übertragungsleitungssystem eingebaut, um einen Synchronisierimpuls hoher Spannung zu erzeugen, sobald die Blitzröhren aufflammen. Dieser Impuls wird durch ein Verzögerungskabel zur Auslöse-Elektrode des Luftspaltschalters geleitet, der den Verschluss der Kerrzelle betätigt. Die Synchronisation geschieht mit einer Genauigkeit von 5 Millimikrosekunden. Die Kamera wurde dazu benützt die ersten Stadien elektrisch explodierter Metallfolien und Höchstgeschwindigkeits-Aufschläge auf einer Schiesstätte zu photographieren.

Multiple Kerr Cell System With Square Shuttering Characteristic

Lothar Liebing, Erich Kollman and Frank Früngel, Dr.Ing. Frank Früngel GmbH, Hamburg-Rissen, Germany

A cable-shaped Kerr cell shutter has been constructed, using solely plug-in parts. A delay cable, with built-in pressure spark gap, forms a square pulse of 35 kv and 50mμsec duration. This pulse passes without reflection by a flexible 9-ft cable, to one or several Kerr cells, interconnected by flexible cables, whereupon the pulse disappears into a terminal resistor. This

Système à cellules de Kerr multiples à caractéristique d'obturation rectangulaire

Lothar Liebing, Erich Kollman et Frank Früngel, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Allemagne

Un nouveau système de commande pour une ou plusieurs cellules de Kerr a été réalisé. Il est composé d'éléments pouvant facilement rtre connectés entr'eux. Un éclateur de commande, fonctionnant dans l'azote sous pression, et un cable de retard fournissent une impulsion rec-

Mehrfach-Kerrzellensystem mit rechteckiger Verschlusscharakteristik

Lothar Liebing, Erich Kollman und Frank Früngel, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Deutschland

Basierend auf den Forschungsarbeiten von Dipl.-Phys. Liebing wurde ein neuer und völlig kabelförmiger Kerrzellenverschluss konstruiert, der ausschliesslich Einsteckteile verwendet. Ein Verzögerungskabel mit eingebauter Druckfunkenstrecke funkt einen Rechteckimpuls von 35 kv und 50 m/μs Dauer. Dieser Impuls passiert ohne Reflektion ein biegsames 2,70 m langes

device features square shuttering characteristic and great mobility. Multiple cells permit simultaneous photography of a subject from several angles. Using delay cables the Kerr cells operate at preset intervals depicting successive stages of the event.

Owing to the very low capacity of the pulse-forming cable, recharging of the system is rapid, thus the picture-taking rate is limited only by the quality of the quenching spark gap. The pulse can also be guided through the cell along meander-shaped electrodes, making possible the construction of large-size cells. Retarders can also fire cell systems at any desired picture-taking rate. When synchronized with high-frequency spark light sources (such as the ultra-rapid flasher, Strobokin), an appreciably shortened square exposure time is achieved. For the ultraviolet range a similar Kerr cell system with phenyl isocyanate is available.

tangulaire de 35 kv d'une durée de 50 mμsec. Cette impulsion traverse sans réflexion un cable flexible de 2,70 m de longueur, une ou plusieurs cellules de Kerr et disparait dans une résistance terminale ne produisant pas de réflexions. Les avantages du système comprennent impulsion à caractéristique rectangulaire et grande mobilité. Des cellules de Kerr multiples permettent la prise de vues simultanées du sujet sous différents angles. Lorsqu'on utilise des cables de retard entre les cellules de Kerr, celles-ci fonctionnent à des intervalles choisis d'avance et permettent de saisir des phases successives du phénomène.

Par suite de la très faible capacité du cable formant l'impulsion, le système se recharge très rapidement. De ce fait, la fréquence de vues est limitée exclusivement par la qualité de l'éclateur d'extinction. L'impulsion peut également rtre envoyée à travers de cellules à électrodes multiples, de sorte qu'il est possible de faire usage de cellules de grandes dimensions. A l'aide de dispositifs retardateurs, il est possible de déclencher plusieurs systèmes à cellules de Kerr à n'importe quelle fréquence d'images désirée. En synchronisant ce système à cellules de Kerr avec des sources d'éclairs à haute fréquence (lampe éclair à haute fréquence Strobokin), on réalise des temps de pose sensiblement plus courts à caractéristique rectangulaire. Pour le travail en ultra-violet, il existe un système à cellules de Kerr similaire, faisant usage de dissocianate de phényle.

Kabel, eine oder mehrere Kerrzellen die ebenfalls durch flexible Kabel miteinander verbunden sind, worauf der Impuls dann in einen Abflusswiderstand reflexfrei verschwindet. Vorteile dieser Einrichtung sind Rechteckige Verschlusscharakteristik und grosse Beweglichkeit. Mehrfach-Kerrzellenanordnungen gestatten die gleichzeitige Aufnahme eines Objektes aus mehreren Aufnahmerichtungen. Bei Verwendung von Verzögerungskabeln zwischen den Kerrzellen arbeiten diese mit vorgegebener Frequenz und erfassen verschiedene Phasen des Vorganges.

Wegen der sehr niedrigen Kapazität des impulsbildenden Kabels ist die Nachladung des Systems sehr schnell. Dadurch ist die Bildaufnahmefrequenz einzig und allein durch die Qualität der verwendeten Löschfunkenstrecke begrenzt. Der Impuls kann ebenfalls durch die Zelle über mäanderförmige Elektroden geleitet werden, so dass damit der Bau von Grosszellen möglich wird. Mit Hilfe von Retardern können auch mehrere Kerrzellensysteme mit jeder gewünschten Bildfrequenz ausgelöst werden. Wenn dieses Kerrzellensystem mit hochfrequenten Blitzlichtquellen (Hochfrequenz-Blitzgerät Strobokin) synchronisiert werden, erzielt man eine erheblich verkürzte rechteckige Belichtungszeit. Für den ultra-violetten Bereich ist ein ähnliches Kerrzellensystem erhältlich, dass Phenyl-Dissozianat (Phenyl-Senföl) verwendet.

TUESDAY 10:45 A.M. SESSION: Intensification Techniques

High-Sensitivity Television as an Aid to Low Light Level Photograhic Recording

BERNARD A. BANG, The Bendix Corp., Friez Instrument Div., Baltimore, Md.

High-sensitivity closed-circuit television equipment can be used as an aid to recording a scene where the effective exposure limitation is below the capability of direct photography. The monitor presentation is photographed by normal techniques. The effective speed of such systems has been increased rapidly during the past three years. Equivalent ASA ratings in excess of 100,000 are now available.

The sensitivity of a well-designed closed-circuit television equipment is determined primarily by the pickup tube and the optics. The most sensitive tube available for the past several years has been the image orthicon or its variations. The sensitivity has been increased to the point that the statistical variation in light photons received is a limitation. The characteristics of these tubes, mode of operation and relative sensitivity are discussed.

La télévision à haute sensibilité comme aide à l'enregistrement photographique à faible niveau lumineux

BERNHARD A. BANG, The Bendix Corp., Friez Instrument Div., Baltimore, Md.

L'équipement de télévision à circuit fermé et à haute sensibilité peut être employé comme aide à l'enregistrement d'une scène dans les cas où la limitation effective d'exposition est en-dessous des possibilités de la photographie directe. La présentation de controle est photographiée par les techniques normales. La vitesse effective de ces systèmes a été rapidement accélérée au cours des trois dernières années. Des évaluations ASA équivalentes supérieures à 100.000 sont maintenant disponibles.

La sensibilité d'un équipement de télévision à circuit fermé judicieusement conçu dépend principalement du tube capteur et du système optique. Le tube le plus sensible qu'on pouvait obtenir depuis plusieurs années était le tube orthicon à images ou ses variantes. La sensibilité a maintenant été augmentée à un point tel que la variation statistique des photons lumineux reçus est une limitation. L'auteur passe en revue les caractéristiques de ces tubes, leur mode de fonctionnement et leur sensibilité relative.

Hochempfindlichkeits-Fernsehen hilft photographischen Aufnahmen bei niedrigem Lichtpegel

BERNHARD A. BANG, The Bendix Corp. Friez Instrument Div., Baltimore, Md.

Hochempfindlichkeits-Fernsehgeräte mit geschlossenem Stromkreis können dazu dienen eine Szene aufzunehmen, bei der die Belichtungszeit beschränkt und unter der für direkte Photographie nötigen ist. Die Begleitdaten werden auf normale Weise photographiert. Die wirksame Geschwindigkeit solcher Anlagen hat sich in den letzten drei Jahren stark erhöht. Es sind gegenwärtig Lichtstärken verfügbar die mehr als 100.000 ASA entsprechen.

Die Empfindlichkeit eines gut gebauten Fernsehgeräts für geschlossenen Stromkreis hängt hauptsächlich von der Aufnahmeröhre und der Optik ab. Die empfindlichste Röhre, die in den letzten Jahren erhältlich war, ist die Image Orthicon oder ihre Varianten. Die Empfindlichkeit wurde bis zu einem solchen Punkt gesteigert, dass die Grenze durch die statistische Variation an aufgenommenen Lichtphotons gebildet wird. Es werden die Charakteristiken dieser Röhren, ihre Arbeitsweise und ihre relative Empfindlichkeit erörtert.

Electronic Image Intensification: Image Intensifier Using Cathode-Conductivity

R. A. Chippendale and J. R. Folkes, Associated Electrical Industries (Woolwich) Ltd., Harlow, Essex, England

Recent work on an electron microscope image intensifier has established that thin films of amorphous selenium can give charge multiplication in the region of 2000 when bombarded with high-energy electrons. A sealed-off tube achieving prescanning amplification in a similar selenium film is described. In the "writing" function, electrons from a semitransparent photoemissive cathode are focused and accelerated into a 10-μ self-supporting selenium film. The provision of an electron transparent signal plate on the front surface of the film enables charges to be driven to the rear whence they are removed by low-voltage scanning beam which returns the surface to reading-gun-cathode potential. Electrostatic scanning is used in combination with retarding field electrodes to achieve orthogonality.

Overall sensitivity is dependent on both photocathode efficiency and charge multiplication in the selenium, which is itself a function of the writing electron voltage. It can be shown theoretically that the use of a suitably restricted bandwidth and optimized amplifier conditions should enable single photoelectrons to be detected.

L'intensification électronique de l'image: Un intensificateur d'image utilisant la cathodo-conductivité

R. A. Chippendale et J. R. Folkes, Associated Electrical Industries (Woolwich) Ltd., Harlow, Essex, Angleterre

De récents travaux effectués sur un intensificateur électronique d'image microscopique ont démontré que des pellicules minces de sélénium amorphe peuvent donner une multiplication de charge d'environ 2000 quand on les bombarde d'électrons à haute énergie. Les auteurs décrivent un tube hermétiquement fermé qui produit une amplification avant exploration dans une pellicule au sélénium du même genre. Dans la fonction "enregistrement," les électrons émanant d'une cathode photo-émissive demi-transparente sont convergés et accélérés de manière à pénétrer dans une pellicule au sélénium auto-porteuse de 10 microns. L'emploi d'une plaque-signal transparente à électrons sur la surface antérieure de la pellicule permet aux charges d'être chassées à l'arrière d'où elles sont enlevées par un faisceau explorateur à bas voltage qui ramène la surface au potentiel normal de la cathode émettrice. On emploie l'exploration électrostatique en combinaison avec des électrodes inductrices retardatrices pour réaliser l'orthogonalité.

La sensibilité d'ensemble dépend d'une part du rendement photocathodique et d'autre part de la multiplication des charges dans le sélénium qui est à son tour fonction du voltage des électrons d'enregistrement. On peut démontrer théoriquement que l'emploi d'une largeur de bande maintenue dans certaines limites et de conditions optima d'amplification doit permettre de déceler des photoélectrons isolés.

Elektronische Bildverstärkung: Bildverstärker benutzt Kathoden-Leitungsfähigkeit

R. A. Chippendale und J. R. Folkes, Associated Electrical Industries (Woolwich) Ltd., Harlow, Essex, England

Durch jüngst vorgenommene Arbeiten an dem Bildverstärker eines Elektronenmikroskops wurde festgestellt, dass dünne Schichten von amorphem Selen, wenn mit Hochenergie-Elektronen bombardiert, die Aufladung um ungefähr das 2000fache vervielfachen können. Es wird eine geschlossene Röhre beschrieben, welche eine Verstärkung vor dem Abtasten in einer solchen Selenschicht erzielt. Bei der "schreibe"-Funktion werden Elektronen einer halbtransparenten photonausstrahlenden Kathode gesammelt und in eine nicht gestützte Selenhaut von 10 Mikrons hineinbeschleunigt. Dadurch dass an der Vorderseite dieser Haut eine elektronendurchlässige Signalplatte vorgesehen ist, können die Ladungen nach rückwärts getrieben werden, von wo sie durch einen Abtaststrahl niedriger Spannung entfernt werden, der die Oberfläche wieder auf das Potenzial der Ablesekathode zurückbringt. Um Rechteckigkeit zu erzielen wird elektrostatisches Abtasten in Verbindung mit verzögernden Feldelektroden verwendet.

Die Gesamtempfindlichkeit hängt sowohl von der Wirksamkeit der Photokathode wie auch von der Ladungsvervielfachung im Selen ab, die selbst von der schreibenden Elektronenspannung abhängig ist. Es lässt sich theoretisch beweisen, dass es bei Verwendung einer entsprechend beschränkten Bandbreite und optimalen Verstärkungsverhältnissen möglich sein sollte, einzelne Photoelektronen zu entdecken.

Very-High-Gain Image-Intensifier Systems and the Photography of Single Photons with Microsecond Time Resolution

Martin L. Perl and Lawrence W. Jones, The University of Michigan, Ann Arbor, Mich.

A system consisting of image intensifier tubes in cascade has been used to record photographically the very faint images of high energy particle tracks in scintillating crystals. This system, currently in use on experiments in high-energy particle physics, is sufficiently sensitive to record single photoelectrons from the first cathode of the system, and capable of a time resolution of a few microseconds. A short time storage allows an electronic gate to be controlled by the event of interest, so that of 10^6 events/sec occurring, only that one event of particular interest may be recorded.

The image-tube system is described together with a summary of relevant properties of available image tubes and lenses. The limitations due to noise and resolution and the improvements to be anticipated from image tubes are discussed.

Des systèmes intensificateurs d'images à rapport très élevé et la photographie de photons isolés avec résolution de temps en microsecondes

Martin L. Perl et Lawrence W. Jones, The University of Michigan, Ann Arbor, Michigan

On a utilisé un système composé de tubes intensificateurs d'images en cascade pour enregistrer photographiquement les images très pâles des pistes de particules à haute énergie dans les cristaux scintillants. Ce système, couramment employé dans la physique des particules à haute énergie, est d'une sensibilité suffisante pour enregistrer des photo-électrons isolés de la première cathode du système et est capable d'une résolution de temps de quelques microsecondes. Un emmagasinage de courte durée permet que la vanne électronique soit commandée par le processus en cause, de sorte que sur un total de 10^6 phénomènes survenant par seconde, il est possible d'enregistrer juste celui qu'on vise plus particulièrement.

L'article donne une description du système des tubes à images, ainsi qu'un résumé des propriétés intéressantes des tubes à images et lentilles disponibles. Les auteurs examinent aussi les limites dues aux bruits et à la résolution, ainsi que les perfectionnements à prévoir dans les tubes à images.

Bildverstärkeranlagen besonders hoher Leistung und das Photographieren einzelner Photonen mit einer Zeitauflösung von Mikrosekunden

Martin L. Perl und Lawrence W. Jones, The University of Michigan, Ann Arbor, Michigan

Es wurde eine Anlage von Bildverstärkerröhren in Stufenanordnung verwendet, um die sehr schwachen Bildeindrücke der Spuren von Hochenergie-Partikeln in funkenden Kristallen photographisch aufzunehmen. Diese Methode ist gegenwärtig für Experimente in der Physik der Hochenergiepartikel im Gebrauch, ist genügend empfindlich um einzelne Photoelektronen von der ersten Kathode der Anlage aufzunehmen und gestattet eine Zeitauflösung von wenigen Mikrosekunden. Durch kurzfristiges Auflagern ist es möglich einen elektronischen Verschluss durch den wichtigen Vorgang so regeln zu lassen, dass von 10^6 Vorgängen/s die sich ereignen, nur der eine Vorgang aufgenommen wird, der von besonderem Interesse ist.

Es wird eine Beschreibung der Anordnung der Bildröhren gegeben sowie eine Zusammenfassung der wichtigen Eigenschaften gegenwärge erhältlicher Bildröhren und Linsen. Es folgt ietin Erörterung der durch Geräusch und Auflösung gegebenen Grenzen und der Verbesserungen die von Bildröhren zu erwarten sind.

The Printing of Underexposed Photographs by Means of "Optical Contrasters"

Michel Cloupeau, Laboratoire de Recherches Electroniques de la Sorbonne, Paris, France

Optical contrasters are instruments which are particularly intended for the viewing or printing of very much underexposed photographic films or plates. The principle of these special photographic enlargers consists in having the light pass several times through the film, so that the

Tirage des photographies sous-exposées par les "contrasteurs optiques"

Michel Cloupeau, Laboratoire de Recherches Electroniques de la Sorbonne, Paris, France

Les contrasteurs optiques sont des appareils plus spécialement destinés à permettre l'observation ou le tirage de films ou de plaques photographiques très sous-exposées. Le principe de ces agrandisseurs photographiques spéciaux consiste à faire passer plusieurs fois la lumière à travers le film de sorte que le contraste se trouve à peu

Das Kopieren unterexponierter Aufnahmen mittels "Optischer Kontraster"

Michel Cloupeau, Laboratoire de Recherches Electroniques de la Sorbonne, Paris, Frankreich

Die optischen Kontraster sind Apparate, die ganz besonders dazu bestimmt sind, das Betrachten oder Kopieren stark unterexponierter photographischer Filme oder Platten zu ermöglichen. Das Prinzip dieser speziellen photographischen Vergrösserungsapparate besteht

contrast is approximately multiplied by the number of passages effected.

In the contraster type A the film is placed between two semireflecting plates which are mounted at a very small angle to each other, and illuminated by collimated light. The emerging light consists of beams which have passed the film one, three, five or more times. Their directions are slightly different so that it is possible to choose any one of these beams. In the contraster type B the film image is reformed on itself by means of an objective-mirror system. Several printing tests prove the efficiency of these instruments which may lead to a systematic improvement of the performance of cameras, or the utilization of accidentally underexposed negatives.

près multiplié par le nombre de passages effectués. Dans le contrasteur type A, le film placé entre deux lames semi-réflectrices formant entre elles un angle très petit est éclairé en lumiére parallèle. La lumière émergente est composée de faisceaux qui ont respectivement traversé le film une, trois, cinq fois et plus. Leurs directions sont légèrement différentes ce qui permet de sélectionner l'un quelconque de ces faisceaux. Dans le contrasteur type B, on reforme l'image du film sur lui-même au moyen d'un système objectif-miroir. Divers essais de tirages démontrent l'efficacité de ces dispositifs qui permettent donc d'envisager l'amélioration systématique des performances des appareils de prises de vues, ou l'utilisation des negàtifs accidentellement sous-exposés.

darin, dass man das Licht mehrmals durch den Film durchgehen lässt, so dass der Kontrast ungefähr mit der Anzahl der Durchgänge multipliziert wird.

Beim Kontraster Typ A wird der Film zwischen zwei, in einem kleinen Winkel zu einander angeordnete, halbreflektierende dünne Platten gebracht und durch paralleles Licht beleuchtet; das austretende Licht besteht aus Strahlenbündeln, die den Film, je nachdem, einmal, dreimal, fünfmal oder öfter passiert haben. Ihre Richtungen sind etwas von einander verschieden, wodurch es möglich ist ein beliebiges Strahlenbündel auszuwählen. Beim Kontraster Typ B wird das Filmbild mittels einer Objektiv-Spiegelanordnung auf sich selbst wiedergeformt. Verschiedene Kopierversuche zeigen die Wirksamkeit dieser Apparate, die die Hoffnung zulassen, dass die Leistung der Kameras systematisch gesteigert und die Verwendung zufällig unterexponierter Negative ermöglicht werden wird.

TUESDAY 2:00 P.M. SESSION: Flash X-Ray

A Fifty-Millimicrosecond Flash X-ray System for High-Speed Radiographs

F. J. Grundhauser and W. P. Dyke,
Field Emission Corp., McMinnville, Ore.

The recently developed temperature-and-field emitter is useful in applications requiring both high resolution and high speed. The cathode has been applied to a family of new x-ray tubes operating at currents and voltages up to 2000 amp and 600 kv, respectively. Earlier tubes, operating at a pulse length of 0.2 μsec, provide radiographs with good resolution through as much as eight inches of aluminum in a single pulse.

An extrapolation of these techniques to a pulse length of 50 mμsec is given. Resolution and film density are sufficient for a number of hypervelocity mechanisms. The performance of the tube and x-ray system is described.

Un système à rayons X à flash de cinquante millimicrosecondes pour la radiographie à grande vitesse

F. J. Grundhauser et W. P. Dyke, Field Emission Corp., McMinnville, Oregon

L'émetteur dit de température-et-champ, de réalisation récente, est utile dans les applications qui nécessitent à la fois une forte résolution et une grande vitesse. La cathode a été appliquée à une série de nouveaux tubes à rayons X qui fonctionnent à des intensités et des voltages allant jusqu'à 2000 amp et 600 kw respectivement. Des tubes antérieurs, qui fonctionnent à une longueur de pulsation de 0,2 μsec, permettent d'obtenir des clichés radiographiques avec bonne résolution à travers une épaisseur maximum de 8 pouces d'aluminium en une seule prise.

Les auteurs donnent une extrapolation de ces techniques à une longueur de pulsation de 50 mμsec. La résolution et la densité de la pellicule sont suffisantes pour divers mécanismes à hypervitesse. L'article décrit le fonctionnement du tube et du système à rayons X.

Eine 50 Millimikrosekunden Blitz-Röntgenanlage für Hochgeschwindigkeits-Röntgenbilder

F. J. Grundhauser und W. P. Dyke, Field Emission Corp., McMinnville, Oregon

Der kürzlich entwickelte Temperatur- und Feldaussender ist für solche Anwendungszwecke geeignet, für die sowohl hohe Rasterfeinheit als hohe Geschwindigkeit erforderlich sind. Die Kathode wurde bei einer Gruppe neuer Röntgenröhren verwendet, die bei Strömen und Spannungen bis zu 2000 A bezw. 600 kW arbeiten. Frühere Röhren, die bei einer Impulslänge von 0,2 Mikrosekunden arbeiteten, ergeben Bilder guter Schärfe, durch bis zu 8 Zoll Aluminum in einer einzigen Aufnahme.

Es wird eine Extrapolierung dieser Methoden bis zu einer Impulslänge von 50 Millimikrosekunden gegeben. Schärfe and Filmdichte sind für eine ganze Anzahl von Höchstgeschwindigkeits-Mechanismen genügend. Es folgt eine Beschreibung der Röhre und der Röntgenanlage.

Triple Installation of Flash Radiography at 600 kv

J. Viard, Poudrerie Nationale, Sevran, France; and L. Beaudouin, Aulnay s/Bois, France

Three armored metal cells are arranged at an angle of 120° to each other and each one contains a generator of flash x-rays. The object to be examined, an explosive, is in the center of symmetry of the setup. The eight-step shock generators produce a shock of 600 kv 300 joules. The synchronisation to a precision of 0.1 μsec is assured. Also the flashes can be delayed in relation to each other from 0 to 100 μsec. The times can be checked afterwards by means of an oscillographic device. The tubes are of the type with conical anode and cold cathode and can operate either as diodes or triodes. Their bulb is made of glass and is sealed, and cylindrical screens protect it from tungsten vapors. The focal diameter depends upon the diameter of the anode stem. The operation of these tubes with regard to voltage, intensity and x-ray emission has been closely studied, both in diode and triode arrangement. It was found again that there is an emission of a plasma from the anode as has been reported already by Shukerman. The very high currents which were observed within the tube can be explained by the Flynn theory, replacing, however, the cathodic jets with this plasma, which moves at a high speed.

Installation triple de radiographie éclair a 600 KV

J. Viard, Poudrerie Nationale, Sevran, France; et L. Beaudouin, Aulnay s/Bois, France

Trois casemates metalliques, disposées à 120°, l'une de l'autre, abritent chacune un générateur de rayons X eclairs. L'objet étudié (explosif) occupe le centre de symétrie de l'ensemble. Les générateurs de choc, à huit étages, produisent un choc de 600 kv 300 Joules. La synchronisation est assurée à 0,1 μsec prés, les éclairs pouvant être retardés l'un par rapport à l'autre de 0 à 100 microseconde. Un dispositif oscillographique permet de controler à posteriori les temps. Les tubes utilisés sont du type à anode conique et à cathode froide. Ils peuvent fonctionner soit en diode soit en triode. Leur enveloppe, en verre et scellée, est protégée de la vapeur de tungstene par des écrans cylindriques. Le diamétre du foyer depend du diamétre de la tige anode. On a étudié en détail le fonctionnement de ces tubes en ce que concerne la tension, l'intensité et l'émission X, avec montage diode et montage triode. On a retrouvé l'émission d'un plasma à partir de l'anode déjà signalé par Shukerman. Les courants tres élevés observés dans le tube peuvent s'expliquer par la théorie de Flynn, mais en remplacant les jets cathodiques par ce plasma qui se déplace à grande vitesse.

Eine Dreifach-Röntgenblitz-Einrichtung von 600 kV

J. Viard, Poudrerie Nationale, Sevran, Frankreich; und L. Beaudouin, Aulnay s/Bois, Frankreich

In jeder von drei Metallkasematten, die in einem Winkel von 120° zu einander angeordnet sind, befindet sich ein Röntgenblitzgenerator. Das zu studierende Objekt (Sprengstoff) ist im symmetrischen Zentrum der Anlage angeordnet. Die achtstufigen Stossgeneratoren erzeugen einen Stoss von 600 kV 300 Joules. Die Synchronisierung wird dadurch auf 0,1 Mikrosekunde genau gesichert, dass die Blitze gegeneinander um von 0 bis 100 Mikrosekunden verzögert werden können. Die Zeiten können nachher mit einem Oszillographen geprüft werden. Die verwendeten Röhren gehören zu dem Typ mit konischer Anode und kalter Kathode; sie können sowohl als Dioden wie als Trioden wirken. Die Glasbirnen sind hermetisch verschlossen und werden durch zylindrische Schirme gegen Wolframdämpfe geschützt. Der Brennpunktdurchmesser hängt von dem Durchmesser des Anodenträgers ab. Die Arbeitsweise der Röhren hinsichtlich Spannung, Intensität und Röntgenstrahlenemission wurde genau studiert, sowohl in Dioden- wie in Triodenanordnung. Es wurde wieder die Emission eines von der Anode ausgehenden Plasmas gefunden, über die schon Shukerman berichtet hatte. Die innerhalb der Röhre gefundenen hohen Ströme lassen sich durch die Flynn-Theorie erklären, indem man jedoch dieses schnellströmende Plasma für den Gasstrahl der Kathode nimmt.

Ladies Program — Tentative

An exceptionally felicitous round of social events and tours combining entertainment with information has been planned for the Ladies Program.

Wednesday, October 19, will begin at 9 A.M. when a bus will leave the hotel for the White House where a special tour will have been arranged. This will be no ordinary tourist excursion, but a privately arranged tour, exclusively for the SMPTE Ladies. The bus is scheduled to arrive at the White House about 9:30 A.M. At 10:15 the bus will take the group to the National Housing Center (sponsored by the National Association of Home Builders) where five floors of exhibits of home furnishings and appliances are on display. After a quick look (about 45 minutes) at all the new and exciting things for the home, the "magic carpet" bus will convey the group to the Wax Museum where great personalities and stirring events in American History are represented in life-like wax models that give a feeling of immediacy, "as if you were really there." Next stop on the tour will be the famous Watergate Inn on the Potomac River, where a "Dutch Treat" lunch will climax a crowded morning. After lunch the bus will take the group back to the hotel.

Other tours being planned include visits to various embassies and a tour of the great religious edifices of Washington — the B'nai Brith, the Islamic Mosque, Shrine of the Immaculate Conception (Catholic), and the Washington Cathedral (Episcopal).

A fashion-show luncheon has been discussed, but plans have not been finalized.

On Saturday ladies are invited to attend a tour and tea sponsored by the Alexandria Junior Women's Club of Alexandria. (Tickets $3.00; proceeds to go to charity.) The tour will include visits to the Indian, Malayan, Turkish and Russian Embassies, the Islamic Club and the famous Japanese Tea House.

Tentative Roster of Committee Meetings

Tuesday, October 18

9:00 A.M. Papers Committee
10:00 A.M. Board of Editors
11:00 A.M. Publications Advisory Committee
12:15 P.M. Editorial Luncheon

Wednesday, October 19

10:00 A.M. Association of Cinema Laboratories
12:00 A.M. ACL Luncheon

To Be Scheduled—Engineering Committees

Film Dimensions
Instrumentation and High-Speed Photography
16mm and 8mm Motion Pictures

High-Speed X-ray Flash Cinematography of Small Objects

FRANK FRÜNGEL, WALTER THORWART and HEINZ ALBERTI, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Germany

The aim of this research is high-speed x-ray flash cinematography of concealed rapid phenomena in small opaque objects, such as the melting of fuses, performance of sealed contact systems, interior operation of relays, snapping of drilled cables, stapling process of periodicals, etc. The design includes a demountable x-ray flash-tube with replaceable Zuckermann needle-anode; quartz-cylinder with optical plane; radiation range of 30 to 250 kv; variable anode-cathode distance by spring mechanism; energized by pulse transformer, into the primary of which are fed controlled capacitor discharges from 1 to 8 joule; generated by the Strobokin ultra-rapid flasher whose spark gap, via the pulse transformer, triggers the x-ray flashtube which operates in combination with the drum camera.

Frame height is fixed by lead masks. Flashing rate, rotating speed and frame height are independent and adjusted according to setting tables. The maximum flashing rate is 10,000 frames/sec with film traveling at a speed of 100 m/sec and 10 x 35 mm frame size. Total number of frames is 150 (1.5 m film on drum perimeter). Tube–film-path distance ranges from 4 to 8 in. Glow cathode x-ray tubes can also be fed by the same system. Being more powerful due to higher cathode emission, they are, however, rather delicate compared to the Zuckermann needle-anode tube.

Radio-cinématographie à haute fréquence de petits sujets

FRANK FRÜNGEL, WALTER THORWART et HEINZ ALBERTI, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Allemagne

But de la recherche est la radio-cinématographie à haute fréquence de phénomènes fugaces masqués dans de petits objets non transparents, tels que, par exemple, la fusion de coupe-circuits, le fonctionnement de contacts dans des boitiers fermés, la cinématique interne de relais, la rupture de cables tresés, l'agrafage de revues, etc. Principe de construction comprend des tubes à éclairs de rayons X démontables avec anode en forme d'aiguille interchangeable d'après Zuckermann; cylindre en quartz avec fenêtre optiquement plane; gamme de réglage de 30–250 kv; distance anode-cathode réglable par mécanisme à ressort; energie d'un transformateur d'impulsions dont le primaire reçoit des décharges de condensateur commandées de 1–8 joules. Celles-ci sont fournies par la lampe à étincelles à haute fréquence Strobokin, dont l'éclateur, par l'intermédiaire d'un transformateur d'impulsions, amorce le tube à éclairs de rayons X. L'enregistrement se fait au moyen d'une caméra à tambour.

La hauteur de l'image est délimitée par des caches en plomb; la fréquence des éclairs, la vitesse de rotation du tambour et la hauteur de l'image, interdépendantes, sont réglées suivant les indications d'une table. L'appareillage complet admet, par exemple, des fréquences de 10.000 éclairs par seconde pour une vitesse du film de 100 m/sec et un format d'image de 10 × 35 mm. Le nombre total d'images est de 150 (le tambour pouvant porter 1,50 m de film). La distance entre le tube à rayons X et le film peut varier entre 10 et 20 cm. Des tubes à rayons X à cathode incandescente peuvent également être commandés par le même système. Par suite de l'émission plus importante de rayons cathodiques, ils ont une plus grande pénétration, mais ils sont beaucoup plus sensibles que le tube à anode en forme d'aiguille d'après la méthode de Zuckermann.

Hochfrequenz-Röntgenkinematographie kleiner Objekte

FRANK FRÜNGEL, WALTER THORWART und HEINZ ALBERTI, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Deutschland

Ziel der Forschung ist die hochfrequente Röntgenkinematographie von verdeckten schnellen Vorgängen in kleinen undurchsichtigen Objekten wie z.B. das Schmelzen von Sicherungen, das Arbeiten von verkapselten Kontaktsystemen, die innere Kinematik von Relais, das Zerreissen verdrillter Kabel, der Heftvorgang von Zeitschriften usw Der Konstruktionsprinzip enthält Zerlegbare Röntgenblitzröhren mit austauschbarer Nadelanode nach Zuckermann, Quarzzylinder mit optischem Planfenster, Stellungsbereich von 30–250 kv, veränderliche Anoden-Kathoden-Entfernung durch Federmechanismus, Energie eines speisungslosen Impuls-Transformators in dessen Primärwindung gesteuerte Kondensatorentladungen von 1–8 joule geleitet werden. Diese werden von dem Hochfrequenz-Blitzgerät Strobokin erzeugt, dessen Funkenstrecke über den Impuls-Transformator die Röntgenblitzröhre zündet, die wiederum in Verbindung mit einer Trommel-Kamera arbeitet.

Die Bildhöhe wird durch Bleimasken festgelegt, die Blitzfrequenz, die Rotationsgeschwindigkeit und die Bildhöhe sind untereinander abhängig und werden nach Tabellen eingestellt. Das komplette Gerät gestattet z.B. Blitzfolgefrequenzen von 10.000 Blitzen/s bei einer Filmgeschwindigkeit von 100 m/s und einer Bildgrosse von 10 × 35 mm. Die Gesamt-Anzahl der Einzelbilder beträgt 150 (1,5 m Film auf dem Trommelumfang). Die Entfernung zwischen Röntgenröhre und Film liegt zwischen 10 und 20 cm. Röntgenröhren mit Glühkathoden können ebenfalls mit dem gleichen System betrieben werden. Obwohl sie infolge der grösseren Kathodenstrahlemission ein grösseres Durchdrängungsvermögen haben, sind sie jedoch wesentlich empfindlicher im Vergleich zu der oben beschriebenen Nadel-Anodenröhre der Zuckermann-Methode.

Megavolt Flash X-ray Equipment

E. W. WALKER, Atomic Weapons Research Establishment, Aldermaston, Berks, England

(*An informal summary will be presented.*)

Un équipement à rayons X du type flash à mégavolts

E. W. WALKER, Atomic Weapons Research Establishment, Aldermaston, Berks, Angleterre

Megavolt Blitz-Röntgengerät

E. W. WALKER, Atomic Weapons Research Establishment, Aldermaston, Berks, England

Applications of Flash Radiography

J. S. MCVEAGH, Armament Research and Development Establishment, Sevenoaks, Kent, England

The operation of three-electrode, hard-vacuum, flash x-ray tubes is discussed, with particular reference to the use of these tubes in the so-called low-voltage circuit. It is noted that these tubes can give out pulses of x-rays which are very short compared with the "ringing time" of the associated electrical circuit.

A theory is put forward to explain this and other tube characteristics. The theory potulates the production of plasma jet, which is "pumped" from the trigger arc towards the anode by means of the electromagnetic pinch effect. The x-ray exposure time corresponds to the transit time of this jet. The theory also requires that there should be an initial delay after the breakdown of the trigger before there is any appreciable rise of current in the tube. Some evidence of this is given together with some x-ray shadowgraphs illustrating applications of the flash technique.

Les applications de la radiographie à flash

J. S. MCVEAGH, Armament Research and Development Establishment, Sevenoaks, Kent, Angleterre

L'auteur explique le fonctionnement de tubes-éclair à rayons X du type à trois électrodes et vide poussé, en insistant particulièrement sur l'emploi de ces tubes dans le type de circuit dit à bas voltage. On signale que ces tubes peuvent émettre des pulsations de rayons X qui sont très courtes en comparaison du "temps d'oscillation" du circuit électrique associé.

Une théorie est avancée pour expliquer cette particularité, ainsi que les autres caractéristiques de ces tubes. Cette théorie admet en postulat la production d'un jet de plasma qui est "pompé" de l'arc déclencheur vers l'anode par le moyen de l'effet de pincement électromagnétique. Le temps d'exposition aux rayons X correspond à la durée de passage de ce jet. La théorie soutient aussi qu'il doit y avoir un retard initial après la rupture de l'arc déclencheur avant qu'il n'y ait aucune élévation sensible d'intensité de courant dans le tube. L'auteur présente quelques preuves sur ce point, ainsi qu'un certain nombre de clichés radiographiques illustrant les applications de la technique au flash.

Anwendungen der Blitz-Röntgenphotographie

J. S. MCVEAGH, Armament Research and Development Establishment, Sevenoaks, Kent, England

Es wird die Funktion der 3-Elektroden- Hart-Vakuum- Blitz- Röntgenröhren besprochen und zwar mit besonderem Bezug auf die Verwendung dieser Röhren im sogenannten Niederspannungs-Stromkreis. Es wird hervorgehoben, dass diese Röhren imstande sind, Impulse von Röntgenstrahlen auszusenden welche, verglichen mit der "Läutezeit" des dazugehörigen Stromkreises, sehr kurz sind.

Es wird eine Theorie aufgestellt, um diese sowie andere Eigenschaften der Röhre zu erklären. Diese Theorie besagt, dass ein Plasmastrahl entsteht, der vom auslösenden Lichtbogen durch den elektromagnetischen Quetscheffekt zur Anode "gepumpt" wird. Die Röntgenstrahlen-Belichtungszeit entspricht der Übergangszeit dieses Strahls. Die Theorie verlangt auch, dass nach dem Abbrechen des Auslösers eine anfängliche Verzögerung besteht, bevor ein merkliches Ansteigen des Stroms in der Röhre stattfindet. Es wird eine gewisse Beweisführung hierfür erbracht, und es werden einige Röntgenbilder gezeigt, die verschiedene Anwendungen der Blitzmethode illustrieren.

TUESDAY 3:45 P.M. SESSION: Flash X-Ray

X-Ray Flash Cinematography Up to 12,000 Images/Sec

A. Stenzel and G. Thomer, Institut Franco-Allemand de Recherches, St. Louis, France

In a continuation of experiments reported at the last High-Speed Congress (1958) the authors study the conditions that determine the maximum frequency of periodic discharges through a flash x-ray tube. With the earlier device, using direct triggering of the tube and simple R-C or R-L-C recharging, the limit frequency is about 5000/sec. To get a higher rate, it is necessary to isolate the anode from the discharge condenser during the pauses.

In the new circuit, this controlled separation is attained by a quenched spark gap, which is periodically triggered by an electronic pulse generator. The device allows a precise control of frequency and total frame number. A capacitive voltage divider assures the synchronized pulses to the tube trigger electrode. With an apparatus following this principle, periodic x-ray flashes up to 12,000/sec and a total number of 60 were produced. Image separation is accomplished by means of a drum camera of 80 m/sec speed. As applications, the authors show a frame series of the initiation of a squib and of the liquid metal transition in arc welding.

Radiocinématographie-éclair à des cadences allant jusqu'à 12.000 images/s

A. Stenzel et G. Thomer, Institut Franco-Allemand de Recherches, St.-Louis, France

Poursuivant les essais présentés au dernier Congrès (Cologne 1958) les Auteurs ont étudié les conditions nécessaires à l'augmentation de la fréquence des décharges périodiques dans un tube de rayons X-éclairs. L'ancien montage, dans lequel le retour de la tension anodique était déterminé par un circuit R-C ou R-L-C et le déclenchement des éclairs assuré uniquement par des impulsions sur l'électrode d'amorçage, permettait d'atteindre au plus une fréquence de 5.000/s. En vue d'augmenter la cadence il est nécessaire que la tension anodique reste coupée complètement entre deux décharges.

Dans le nouveau montage la séparation périodique de la capacité de décharge et du tube est realisée par un éclateur d'extinction commandé électroniquement. Ce dispositif permet un choix précis de la fréquence et du nombre total des éclairs. Un diviseur de tension capacitif assure la synchronisation des impulsions de déclenchement sur l'électrode d'amorçage du tube. Avec un appareillage conçu suivant ce principe les Auteurs ont obtenu à 30 kv de tension anodique des séries de 60 éclairs de rayons X à des fréquences allant jusqu'à 12.000/s. La séparation des images est obtenue à l'aide d'une caméra à tambour tournant avec film extérieur tournant à la vitesse maximale de 80 m/s. A titre d'exemple d'application les Auteurs présentent des séquences montrant le transport du matériel dans la soudure à l'arc et la phase primaire du fonctionnement d'un inflammateur électrique.

Kinematographie mit Röntgenblitzen bei Frequenzen bis zu 12.000 Bildern/s

A. Stenzel und G. Thomer, Deutsch-Französisches Forschungsinstitut, St.-Louis, Frankreich

In Fortführung der auf dem letzten Kongress (Köln 1958) vorgetragenen Versuche wurden die Bedingungen untersucht, die für eine Erhöhung der Frequenz periodischer Entladungen durch ein Röntgenblitzrohr von Bedeutung sind. Bei der früher verwendeten Schaltung, bei welcher der Wiederanstieg der Anodenspannung durch einen R-C- bzw. R-L-C-Kreis bestimmt wird und die Steuerung der Blitze allein durch Impulse auf die Zündelektrode des Röntgenrohres erfolgt, liegt die erreichbare Grenzfrequenz bei etwa 5.000/s. Um zu höheren Frequenzen zu gelangen, ist es notwendig, dass die Anodenspannung während der Pausen völlig abgeschaltet bleibt.

Bei der neuen Apparatur wird die periodische Trennung von Entladekapazität und Blitzrohr durch eine elektronisch gesteuerte Löschfunkenstrecke erreicht. Die Anordnung erlaubt eine präzise Einstellung der Frequenz und der Serienlänge. Ein kapazitiver Spannungsteiler sorgt für die nötigen synchronisierten Zündimpulse auf die Triggerelektrode des Röntgenrohres. Mit einer nach diesem Prinzip aufgebauten Apparatur wurden bei 30 kV Anodenspannung periodische Röntgenblitze mit Frequenzen bis zu 12.000/s, bei einer Serienlänge von 60 Blitzen erzeugt. Die Bildtrennung erfolgt mit Hilfe einer Trommelkamera mit Aussenfilm bei 80 m/s maximaler Filmgeschwindigkeit. Als Anwendungsbeispiele werden Ausschnitte aus Bildstreifen gezeigt, welche den Materialübergang bei der Lichtbogenschweissung sowie die Primavorgänge beim Ansprechen einer elektrischen Zündpille sichtbar machen.

Application of Image Intensifier in Flash Radiography

G. Thomer and R. Schall, Institut Franco-Allemand de Recherches, St. Louis, France

For certain applications of flash radiography, particularly diffraction studies, the x-ray intensity of a single flash is not sufficient for direct photographic registration. A further increase of flash specific intensity is not to be expected because of the limited current density at the anode and the required short flash duration, so an improvement of sensitivity of registration might be expected to open new fields of application to flash radiography. One possibility of realizing this is given by the electronic x-ray image intensifier. The authors study the possibilities of application of such a device in flash technique.

A slight loss in definition must be accepted, but this is nearly the same in the stationary case. The image blurs due to development of space charges in the electronic optics by high impulse loads are negligible for dose rates up to 10^4 roentgen/sec. Using an objective of extremely high aperture and highly sensitive film, the gain in sensitivity is about a factor of 10, compared with direct registration using a highly sensitive film. The method will be of interest not only for single-flash photography but also for cinematography with x-ray flashes.

Etude sur l'application de l'intensificateur d'image dans la radiographie-éclair

G. Thomer et R. Schall, Institut Franco-Allemand de Recherches, St.-Louis, France

L'intensité du rayonnement émis par un seul éclair est, à l'heure actuelle, insuffisante pour certaines applications de la radiographie-éclair (p.e. étude des structures cristallines par diffraction) lorsqu'il s'agit d'enregistrements photographiques directs. Une augmentation notable de l'intensité de l'éclair ne peut guère être escomptée; l'émission spécifique de l'anode restera toujours limitée par la puissance que peut supporter l'anode et par ailleurs le temps de pose ne devra évidemment pas excéder les valeurs actuelles (0,2–1,0 μs). Un accroissement de la sensibilité d'enregistrement pourrait donc ouvrir de nouveaux domaines d'application à la technique de la radiographie-éclair. Une possibilité pour une telle amélioration est donnée par les intensificateurs d'image fonctionnant suivant le principe des transformateurs d'image électroniques. Les Auteurs ont étudié expérimentalement les possibilités d'emploi d'un tel appareil pour la radiographie-éclair.

Il s'avère que la définition subit certaines pertes par rapport à l'enregistrement direct mais ceci est également le cas en regime continu. Les défauts de l'image que viennent s'ajouter sous l'influence des charges spatiales en régime discontinu sont négligeables pour des débits jusqu'à 10^4 r/s. La sensibilité par rapport à l'enregistrement direct est dix fois supérieure à condition d'employer une optique à très grande ouverture et un film très rapide. Le procédé peut présenter des avantages non seulement pour des radiographies isolées mais également pour la radiocinématographie à haute fréquence.

Versuche zur Anwendung des Bildverstärkers in der Röntgenblitzphotographie

G. Thomer und R. Schall, Deutsch-Französisches Forschungsinstitut, St.-Louis, Frankreich

Für gewisse Anwendungen der Röntgenblitzphotographie (z.B. bei Feinstrukturuntersuchungen) reicht derzeit die Intensität der bei einem Blitz emittierten Strahlung für eine direkte photographische Registrierung mit Film und Verstärkungsfolien nicht aus. Eine weitere wesentliche Steigerung der Blitzintensität ist kaum zu erwarten; die Leuchtdichte der Anode bleibt aus Gründen der theoretischen Belastbarkeit begrenzt und die Belichtungszeit (0,2–1,0 μs) soll selbstverständlich nicht erhöht werden. Eine Erhöhung der Empfindlichkeit der Registrierung dürfte daher der Röntgenblitztechnik neue fruchtbare Anwendungsgebiete erschliessen. Eine Möglichkeit zu einer solchen Verbesserung bieten die nach dem Prinzip der elektronischen Bildwandler arbeitenden Röntgenbildverstärker. In der vorliegenden Arbeit wird experimentell die Anwendbarkeit eines solchen Gerätes in der Blitztechnik geprüft.

Es zeigt sich, dass man zwar einen gewissen Verlust an Auflösungsvermögen gegenüber der direkten Registrierung in Kauf nehmen muss, aber dies gilt schon für den stationären Fall. Die zusätzlich durch Raumladungen im Elektronenbild bei Impulsbelastung auftretenden Bildfehler sind bis zu Dosisleistungen von 10^5 r/s vernachlässigbar. Als Gewinn an Empfindlichkeit ergibt sich bei Verwendung lichtstärkster Optik und hochempfindlichen Films etwa ein Faktor 10 gegenüber der direkten Registrierung. Das Verfahren kann ausser für Einzelaufnahmen auch für Hochfrequenzkinematographie mit Röntgenblitzen von Vorteil sein.

High-Speed Radiographic and Optical Techniques Applied to Hypervelocity Impact Studies

J. William Gehring, Jr., Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

The phenomenon of target behavior on impact by a projectile traveling at hypervelocities has been the subject of active study for many years. Although a number of contradictory theories have been proposed to describe the mechanism of crater formation, it is generally agreed that at hypervelocities an impacting meteorite or metal particle will penetrate by a complex mechanism that includes compression of the target and projectile by shock, as well as by hydrodynamic flow of the material under high pressures and temperatures. Later in the process the pressures and velocity are reduced to a degree that ordinary target material strengths become all-important. In order to describe the mechanism, in terms of physics, it is necessary to design experiments which test those items of the theory which are currently treated only as assumptions.

The techniques used to observe an expanding shock wave in transparent materials with a Beckman & Whitley, continuously recording, 80-frame camera are described. 0.2-μsec flash radiographic techniques were used to demonstrate the manner in which craters are formed in opaque materials. In addition, radiographs provided the measurement of crater expansion and partial recovery with time, as well as the analysis of free surface effects. The method used to determine from radiographs the material density surrounding an expanding crater is discussed. Both the optical and radiographic equipment used in these experiments are evaluated in terms of ease and facility of use, reproducibility, reliability and relative merits.

L'emploi des techniques rapides du type radiographique ou optique dans les études d'impact aux hypervitesses

J. William Gehring, Jr., Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

Le phénomène du comportement de l'objectif sous l'impact d'un projectile lancé à des hypervitesses est, depuis de nombreuses années, l'objet de multiples études. Bien que diverses théories contradictoires aient été avancées pour expliquer le mécanisme de formation du cratère, on est généralement d'accord pour reconnaitre que, lors de l'impact aux hypervitesses, une météorite ou particule métallique pénètre l'objectif sous l'effet d'un mécanisme complexe qui comprend la compression de l'objectif et du projectile sous le choc, ainsi que le refoulement hydrodynamique de la matière sous l'effet des fortes pressions et des hautes températures. A un point ultérieur du processus, les pressions et la vitesse diminuent à un degré tel que les résistances normales de la matière de l'objectif deviennent le facteur dominant. Afin de pouvoir décrire le mécanisme du processus en termes de physique, on a du élaborer des essais capables de vérifier ceux des éléments de la théorie encore considérés comme de simples hypothèses.

L'auteur décrit les techniques mises en oeuvre pour observer un choc en expansion dans des matières transparentes au moyen d'une caméra Beckman & Whitley à 80 images et enregistrement continu. On a employé des techniques radiographiques à flash de 0,2 μs pour démontrer de quelle manière les cratères se forment dans les matières opaques. En outre, des clichés radiographiques ont permis le mesurage de la dilatation des cratères et de leur retrait partiel avec le temps, ainsi que l'analyse des effets de surface libre. L'auteur explique la méthode qui a été employée pour déterminer par l'examen de ces clichés radiographiques la densité de la matière qui entoure un cratère en voie de dilatation. Tant l'équipement optique que l'équipement radiographique utilisés dans ces expériences sont évalués aux points de vue de l'aisance et de la facilité d'emploi, de l'aptitude à la répétition, de la sûreté des observations et des mérites comparatifs.

Hochgeschwindigkeits-Röntgen- und Optische Methoden bei der Untersuchung von Aufschlägen mit Höchstgeschwindigkeit

J. William Gehring, Jr., Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

Durch viele Jahre wurde das Verhalten des Zieles beim Aufschlag eines mit Höchstgeschwindigkeit kommenden Geschosses eingehend studiert. Eine Anzahl einander widersprechender Theorien wurden aufgestellt, um das Entstehen des Kraters zu beschreiben; es wird jedoch allgemein angenommen, dass bei Höchstgeschwindigkeiten ein aufschlagender Meteorit oder Metallteil durch einen komplizierten Vorgang eindringt, zu dem eine Kompression des Zieles und des Projektils einerseits durch Stoss und andererseits durch hydrodynamischen Fluss des Materials unter hohen Drücken und Temperaturen gehören. Im späteren Teil des Vorgangs werden Druck und Geschwindigkeit so weit herabgesetzt, dass die Stärke des Materials des Zieles die Hauptbedeutung hat. Um die mechanischen Vorgänge physikalisch zu beschreiben ist es notwendig, Versuche zu finden, welche jene Teile der Theorie prüfen, die gegenwärtig nur als Annahmen behandelt werden.

Es werden die Methoden beschrieben, um eine sich ausbreitende Stosswelle in transparentem Material mit einer kontinuierlich arbeitenden 80-Bild Beckman und Whitley- Kamera zu beobachten. Um zu zeigen, wie die Krater in undurchsichtigen Stoffen entstehen, wurden Röntgenverfahren mit 0,2 Mikrosekunden-Blitz angewendet. Die Röntgenbilder geben auch die Masse der Kraterausweitung und die teilweise Wiederherstellung nach einer gewissen Zeit und eine Analyse der freien Oberflächeneffekte. Es wird die Methode erörtert, nach der aus den Röntgenbildern die Dichte des den sich erweiternden Krater umgebenden Materials bestimmd wird. Sowohl die optischen wie die Röntgengeräte, welche für diese Versuche in Anwendung kamen, wurden daraufhin abgewertet, wie einfach sie in der Anwendung sind und hinsichtlich der Wiederholbarkeit, Verlässlichkeit und relativer Vorzüge.

Measurements of the Density of Gas in an Argon-Discharge by Soft X-Ray Flashes

Karl Vollrath, Institut Franco-Allemand de Recherches, St.-Louis, France

The relation between electrical recovery time and the increase in gas-density after a primary spark was experimentally studied in an argon discharge. For this purpose single photos were taken by soft X-ray flashes in the direction of the discharge-channel at different moments after the argon-discharge. The absorption of X-rays and therefore the density of the gas was recorded by a film behind the electrodes. The radial distribution of gas-density in the channel was obtained from the film by photometry.

By this method the density of gas in the channel was determined at times from a few microseconds up to 1.5 ms after the discharge. Thereby the density increase of the gas was found to be in direct relation to the electric recovery of the spark.

Mesures de la densité gazeuse dans une décharge d'argon par des éclairs de rayons X mous

Karl Vollrath, Institut Franco-Allemand de Recherches, St.-Louis, France

La relation entre le temps de rétablissement électrique et l'accroissement de densité gazeuse après une étincelle primaire a été étudiée expérimentalement dans une décharge d'argon. A cette fin, on a pris des photos séparées au moyen d'éclairs de rayons X mous dans le sens du conduit de décharge à des moments différents après la décharge d'argon. L'absorption des rayons X, et partant la densité du gaz, a été enregistrée par un film derrière les électrodes. La répartition radiale de la densité gazeuse dans le conduit a été obtenue à partir du film par photométrie.

On a pu déterminer par cette méthode la densité du gaz dans le conduit à des temps allant de quelques microsecondes jusqu'à 1,5 ms. Par suite, on a constaté que l'augmentation de densité du gaz était en relation directe avec le rétablissement électrique de l'étincelle.

Die Bestimmung der Gasdichte in einer Argon-Entladung mit Hilfe von weichen Röntgenblitzen

Karl Vollrath, Deutsch-Französisches Forschungsinstitut, St.-Louis Frankreich

Der Zusammenhang zwischen elektrischer Wiederverfestigung und zeitlicher Zunahme der Gasdichte nach einer primären Entladung wurde nun im Falle des Argonfunkens experimentell untersucht. Zu diesem Zweck wurde der Entladungskanal eines Argonfunkens mit Röntgenblitzen besonders weicher Strahlung in Richtung des Kanals zu verschiedenen Zeiten nach dem Durchschlag durchstrahlt. Die Absorption der Röntgenstrahlung und damit die radiale Dichteverteilung des Gases im Kanal wurde aus der Schwärzung eines hinter der Entladung befindlichen Filmes photomässig bestimmt.

Der Zeitliche Zwischenraum wurde dabei von wenigen Mikrosekunden bis 1,5 ms variiert. Man findet dass die zeitliche Zunahme der Gasdichte nach dem Durchschlag der elektrischen Wiederverfestigung entspricht.

—— TUESDAY 8:00 P.M. AWARDS SESSION

Guest Speaker: J. Lewis Powell, Office of the Assistant Secretary of Defense, speaks on "Muscles to Missiles."

OCTOBER 19 —WEDNESDAY 9:30 A.M. SESSION: Equipment Papers and Demonstrations (See the Exhibit Directory)

—— WEDNESDAY 2:00 P.M. SESSION: Unusual Techniques .....

Some Unconventional Methods of High-Speed Photography

J. S. COURTNEY-PRATT, Bell Telephone Laboratories, Inc., Murray Hill, N.J.

Part I. Image Dissection Photography. It is possible to increase the rate at which pictures can be taken, by making use of the principles of image dissection. In this, the picture is divided up into a large number of small elements which may be lines or dots, and these are all recorded simultaneously on a photographic emulsion. The elements are spaced out so that (in at least one dimension) each is separated from its neighbors by a distance that is large compared with the width of the element. A second picture can be recorded by displacing the image with respect to the emulsion by the width of the image element rather than by the width of a frame, and this allows one to achieve the much higher recording rate. A brief description is given of the methods that I have developed over the last few years applying this principle of image dissection to different systems of photography.

Part II. A Lenticular Plate Multiple Picture Shadowgraph Recording System. New apparatus has been built using image dissection principles so that one can take a series of twelve shadowgraphs each of exposure duration less than 1 μsec, and interval between the pictures anything convenient from 1 sec to 2 μsec. The resolution is 600 lines across the field each way.

Part III. A High-Speed X-ray Recording System. Image dissection techniques are considered. Measurements of spaced arrays of fiber light guides indicate their suitability as the dissection system for recording short series of x-ray shadowgraphs at rates up to 10^8 or more per second.

Part IV. High-Speed Photography Using a Sectioned Lens. A lens has been cut into segments, spacing pieces have been inserted, and all these pieces have been cemented together as a compact composite assembly. This assembly produces a number of separate real images of the object. These images can be selected and recorded sequentially by the rotation near the assembly of a small disk in which is a suitable aperture.

Certaines méthodes non-courantes de photographie à grande vitesse

J. S. COURTNEY-PRATT, Bell Telephone Laboratories, Inc., Murray Hill, N.J.

Partie I. La photographie à dissection des images. Il est possible d'augmenter la cadence à laquelle les photos sont prises en tirant parti des principes de la dissection des images. Selon ce procédé, l'image est divisée en un grand nombre de petits éléments qui peuvent être des lignes ou des points, et ceux-ci sont tous enregistrés simultanément sur une émulsion photographique. Les éléments sont espacés (tout au moins dans un sens) de telle manière que chacun d'eux est séparé des éléments voisins par une distance qui est grande en comparaison de la largeur de l'élément. Une deuxième photo peut être enregistrée en déplaçant l'image par rapport à l'émulsion de la largeur de l'élément d'image plutôt que de la largeur d'une image entière, ce qui permet à l'opérateur d'atteindre une cadence d'enregistrement beaucoup plus rapide. L'auteur donne une description succinte des méthodes qui ont été mises au point en appliquant ce principe de dissection des images à divers systèmes de photographie.

Partie II. Un système d'enregistrement ombrographique multi-images à plaque lenticulaire. On a réalisé un nouvel appareil qui applique les principes de dissection d'image d'une manière telle que l'opérateur peut prendre une série de douze photos ombrographiques ayant chacune une durée d'exposition de moins de 1 μs et avec un intervalle entre les images successives pouvant varier commodément de 1 s à 2 μs. La résolution est de 600 lignes en travers du champ dans les deux sens.

Partie III. Un système d'enregistrement à grande vitesse à rayons X. L'auteur examine les techniques à dissection d'image. Les résultats des mesures de séries espacées de guides lumineux de fibres indiquent que l'emploi en est approprié comme système de dissection pour l'enregistrement de courtes séries de photos ombrographiques à rayons X avec des cadences allant jusqu'à 10^8/s ou plus.

Partie IV. La photographie à grande vitesse avec emploi d'un objectif sectionné. Un objectif a été divisé en segments entre lesquels on a intercalé des éléments espaceurs; on a ensuite cimenté tous ces éléments de manière à former un ensemble combiné très compact. Cet ensemble produit un certain nombre d'images réelles et séparées de l'objet photographié. Ces images peuvent être choisies et enregistrées en série par la rotation, à proximité de l'ensemble, d'un petit disque dans lequel on a ménagé une ouverture appropriée.

Einige ungewöhnliche Verfahren der Hochgeschwindigkeits-Photographie

J. S. COURTNEY-PRATT, Bell Telephone Laboratories Inc., Murray Hill, N.J.

Teil I. *Bildzerlegungs-Photographie.* Es ist möglich die Bildaufnahmefrequenz dadurch zu erhöhen, dass man die Grundsätze der Bildzerteilung anwendet. Hierbei wird das Bild in eine grosse Anzahl kleiner Elemente zerlegt, entweder Linien oder Punkte, und alle diese werden gleichzeitig auf der photographischen Schicht aufgenommen. Diese Elemente haben einen gewissen Abstand voneinander, so dass jedes—wenigstens in einer Richtung—von seinen Nachbarn durch einen Abstand getrennt ist, welcher grösser ist als die Breite des Elements. Durch Verschieben des Bildes in Beziehung auf die Schicht um die Breite eines Bildelements—statt der Breite des Bildes—lässt sich ein zweites Bild aufnehmen und damit die Bildfrequenz bedeutend steigern. Es wird eine kurze Beschreibung der Methoden gegeben, die ich in den letzten Jahren ausgearbeitet habe, wobei dieses Prinzip der Bildzerlegung auf verschiedene Systeme der Photographie angewendet wird.

Teil II. *Eine Anlage für Mehrfach-Schattenaufnahmen mit lentikulärer Platte.* Es wurde ein neuer Apparat gebaut, der die Grundsätze der Bildzerlegung anwendet, wodurch es ermöglicht wird, eine Reihe von je zwölf Schattenaufnahmen mit einer Belichtungszeit von weniger als 1 Mikrosekunde und mit Zeitintervallen zwischen Aufnahmen nach Belieben zwischen 1 Sekunde und 2 Mikrosekunden zu machen. Die Auflösungsfeinheit ist 600 Linien über das Feld in jeder Richtung.

Teil III. *Eine Anlage für Hochgeschwindigkeits-Röntgenaufnahmen.* Es werden die Methoden der Bildzerlegung betrachtet. Messungen von in Abständen angeordneten Gruppen von Faser-Lichtleitern ergeben ihre Geeignetheit als die Zerlegungsanlage zum Aufnehmen kurzer Reihen von Röntgen-Schattenaufnahmen mit Frequenzen von 10^8/s und darüber.

Teil IV. *Hochgeschwindigkeits-Photographie mit Hilfe einer segmentierten Linse.* Es wurde eine Linse in Segmente geschnitten und zwischen diese wurden Stücke als Abstandshalter eingesetzt; schliesslich wurden alle diese Stücke zu einem kompakten zusammengesetzten Bauteil zusammengekittet. Dieser zusammengesetzte Bauteil liefert eine Anzahl getrennter Realbilder des Objekts. Diese Bilder können ausgewählt und in Sequenz festgehalten werden, indem nahe dem genannten Bauteil eine kleine rotierende Scheibe angebracht wird, die eine zweckentsprechende Öffnung hat.

New Developments in the Courtney Pratt High-Speed Camera

M. B. PRUDENCE, J. Langham Thompson Ltd., London, England

Développements nouveaux dans la caméra à grande vitesse Courtney Pratt

M. B. PRUDENCE, J. Langham Thompson Ltd., London, Angleterre

Neue Entwicklungen im Courtney-Pratt-Hochgeschwindigkeitskamera

M. B. PRUDENCE, J. Langham Thompson Ltd., London, England

He has always thought a pick was the tool with which the Erie Canal was dug.

He thinks "D Max" is the name of a guy who might have been called "Dave" but wanted a classier handle.

Dr. F. W. Spangler (left) meets R. C. Hilton, senior geophysicist in charge of geophysical data processing for Shell Oil Company, Houston. Purpose of the visit is to familiarize Dr. Spangler directly with the ideal characteristics which Shell desires in a polyester recording film for use in the Reynolds Plotter. Dr. Spangler is an assistant superintendent of Kodak's Film Emulsion Division.

With the switch to thin, rugged Estar Base that eliminates troublesome dimensional change, Fred Spangler had to decide what inherent maximum density to give the new **Kodak Linagraph Recording Film.** Dick Hilton needs more from a film than that it shouldn't be troublesome. He doesn't talk Fred's "D Max" language. He seeks a certain appearance to which his perceptual process best responds in picking a "pick" from the corrected cross-section which the Plotter puts on the film. Spangler learned plenty from him and from others with other instrumentation and other perceptual patterns of translating photographic images into technical intelligence.

Photorecording Methods Division

EASTMAN KODAK COMPANY, Rochester 4, N.Y.

New Methods in Design and Computing for Special Optical Systems

RAPHAEL BOOLSKY, Consultant, Geneva, Switzerland

A new axiomatic method, applicable to wide-aperture, wide-angle and other special optical systems, has been developed for their analysis and design. It permits determination readily of the optical properties which would be compatible with an optical system in its early planning stage, without requiring a detailed knowledge of all parts of the system, and is helpful in the actual synthetic design that follows.

The necessary conditions for imaging sharply elements of lines and surfaces are generally defined by the laws of light propagation, and more specifically by Abbe's Sine Law and its corollary, the Cosine Law. The axiomatic method has been derived from these laws by developing them into new geometric constructions for tracing physically correct incident and refracted rays and representing so-called "iconic models" of perfect optical systems.

This method, which is quite different from Gauss' abstract ray tracing procedure, has been applied to the study of the characteristics and practical realization of optical combinations approaching their "iconic" models. Of particular interest are such systems having a spherical image surface used in combination with field flatteners to obtain a sharp image in a plane, and symmetrical combinations which have approached apertures of $f/0.5$.

Nouvelles conceptions en optique instrumentale

RAPHAEL BOOLSKY, Genève, Suisse

La prise de vue à grande vitesse peut bénéficier d'améliorations fondamentales des concepts théoriques del'optique instrumentale. En particulier, une nouvelle méthode axiomatique permet aujonrd'hui de spécifier à l'avance toutes les propriétés compatibles entre elles que l'on peut réunir dans un instrument optique, puis de conduire avec précision à la synthèse et à la réalisation pratique de cet instrument. Les bases de cette nouvelle méthode axiomatique sont les lois de la propagation de la lumière, en général, et leurs conséquences particulières en ce qui concerne l'imagerie nette d'éléments de lignes et de surfaces, exprimées par les théoremes connus des "cosinus" et des "sinus" découverts par Abbé. Les conséquences tirées de ces théorèmes ont été développées et ont mené à de nouvelles représentations géometriques, différentes de la construction des rayons abstraits imaginée par Guass, et représentant les rayons incidents et émergents d'instruments réels avec netteté une surface image (et non un espace image). Ces constructions graphiques des rayons sont les "modèles iconaux d'instruments parfaits." Ils ont été étudiés pour les principales exigences pratiques. Une autre partie de l'optique axiomatique traite des combinaisons effectives de lentilles propres à réaliser en approximation suffisante une imagerie de surface dont on connaît le modèle iconal. Nous avons beaucoup employé la combinaison d'une composante fournissant une surface focale nette sphérique avec un élément redresseur, l'ensemble constituant un objectif conventionnel de qualité. Des combinaisons symétriques ont encore permis d'approcher les ouvertures de $f/0,5$ avec des résultats remarquables.

Neue Begriffe und Rechnungsmethoden der axiomatischen Optik

RAPHAEL BOOLSKY, Genf, Schweiz

Jede Verbesserung der optischen Systeme und deren theoretischen Grundlagen kann eine Auswertung im Gebiete der Photographie finden. Ganz besonders, neue axiomatische Methoden sind heute fähig von vorneraus eine Angabe über alle möglichen Leistungen optischer Systeme zu verfügen, wobei diese Systeme nicht in Einzelheiten bekannt sind. Die natürliche Grundlage aller optischen Theorien ruht auf Eigenschaften der Lichtausbreitung. Die besonderen Grundlagen der axiomatischen Optik ruhen auf Theoreme. (Das Cosinus Theorem, betreffend die nötigen Bedingungen für eine scharfe Abbildung von Linienelementen und Flächenelementen steht als Verallgemeinerung des Abbe'schen Theorems der "Sinus" im Vordergrund.) Als Folgen dieser Theoreme finden wir neue geometrischen Konstruktionen, sogenannte "Ikonale Modelle," welche die Gauss'sche Konstruktion ersetzen und für jeden praktischen Fall die wahre Korrespondenz zwischen ein- und aus-tretenden Strahlen darstellen.

Ein weiterer Schritt der neuen Methoden betrifft die optischen Zusammensetzungen von Linsen, welche eine gegebene scharfe Abbildung einer gegebener Objekt-Fläche in der Tat annährungsweise bewirken. Wir brauchen am meisten eine Kombination in welcher die ersten Komponente eine scharfe Abbildung des unendlichen auf eine sphärische Schale zeigt; die zweite Komponente wirkt dabei als Projektiv und Umformer, dazu gebraucht, dass ein scharfes und ebenes Bild endlich geformt wird. Symmetrische Kombinationen solcher Systeme führen zu Objektiven mit sehr grossen Aperturen (beinahe 1:0,5).

Unusual Application of Optical Instrumentation at NOTS

D. KEYES, W. LAMBERT, W. KOINER, G. SILBERBERG and D. TIEMANN, U. S. Naval Ordnance Test Station, China Lake, Calif.

Major optical instrumentation arrays that have been installed in recent years at the test sites and laboratories of the U.S. Naval Ordnance Test Station, China Lake, California. Three categories are covered here:

(1) Underwater environmental problems, including model tank and ocean sites, with emphasis on the problems encountered in the installation of an array of optical systems on the ocean bottom off the shore of San Clemente Island, and the use of natural illumination for data recording; (2) the adaptation of high-speed optical equipment and specialized techniques for gathering experimental data and research and development programs such as ignition problems, flame propagation and grain studies; and (3) tracking of high-speed events, particularly missiles and sleds of supersonic speed and the use of new instrumentation to facilitate data-recording; and Cinetheodolite satellite tracking with reference to data at low-level illumination for determining satellite orbital elements.

Application spéciale des instruments optiques à NOTS

D. KEYES, W. LAMBERT, W. KOINER, G. SILBERBERG et D. TIEMANN, U.S. Naval Ordnance Test Station, China Lake, Californie

Cet article décrit les principaux systèmes d'instruments optiques qui ont été installés au cours de ces dernières années dans les zones d'épreuves et laboratoires de la Station d'Essais de l'Artillerie Navale des Etats-Unis, à China Lake, Californie. Trois catégories de problèmes sont étudiées ici:

(1) Les problèmes de milieu sous-marin, notamment en cuves-modèles et emplacements marins, plus particulièrement les problèmes qui se présentent dans l'installation d'une série de systèmes optiques sur le fond de l'océan au large de la cote de l'Ile San Clemente et l'utilisation de l'éclairement naturel pour l'enregistrement des observations; (2) l'adaptation de l'équipement optique à grande vitesse et des techniques spécialisées pour l'obtention de données expérimentales et pour des programmes de recherches et de développements portant notamment sur les problèmes d'allumage, la propagation des flammes et les études de texture; et (3) le dépistage des processus à grande vitesse, en particulier ceux relatifs aux engins téléguidés et trafneaux de vitesse supersonique, et l'emploi de nouveaux instruments pour faciliter l'enregistrement des observations; et le dépistage inéthéodolite de satellites relatif aux données à faible niveau d'éclairement pour la détermination des éléments orbitaux des satellites.

Aussergewöhnliche Anwendung optischer Instrumente bei NOTS

D. KEYES, W. LAMBERT, W. KOINER G. SILBERBERG und D. TIEMANN, U.S. Naval Ordnance Test Station, China Lake, Kalifornien

In den Laboratorien und Prüfstätten der U.S. Naval Ordnance Test Station in China Lake, Kalifornien, wurden grössere Anlagen von optischen Instrumenten vorgesehen. Der Artikel behandelt drei Gruppen:

1) Probleme der Unterwasserverhältnisse, einschliesslich der Modelltanks und Ozeananlagen, unter Betonung der Probleme, die sich bei der Einrichtung von Gruppen optischer Geräte ergeben, die am Meeresboden bei der Insel San Clemente aufgestellt wurden, sowie die Verwendung von Tageslicht zum Aufzeichnen von Daten; 2) die Anpassung optischer Hochgeschwindigkeitsgeräte und besonderer Methoden um Versuchsdaten zu erhalten, sowie Forschungs- und Entwicklungsprogramme wie Probleme der Zündung, Flammenausbreitung und Körnerstudien; 3) Verfolgung von Hochgeschwindigkeits-Ereignissen, insbesondere Raketen und Schlitten mit Überschallgeschwindigkeit und den Gebrauch neuer Instrumente zur Erleichterung der Aufnahme von Daten; weiters auch die Wegverfolgung von Raketen durch Kine-Theodoliten zur Erlangung von Daten über die Elemente der Flugbahn, bei schwacher Beleuchtung.

WEDNESDAY 3:45 P.M. SESSION: Stereo, Spectra and Micro Studies .....

Design and Application of a High-Speed Time-Resolving Spectrograph

DONALD BAKER MOORE and JOHN K. CROSBY, Stanford Research Institute, Menlo Park, Calif.

The design and construction of a time-resolving spectrograph having a time resolution of 0.02 μsec and a wavelength resolution of 3 A are described. This instrument was built by The Beckman & Whitley Corp. for the Poulter Laboratories of Stanford Research Institute for use in the study of high-explosive phenomena. Calibration of the instrument by use of a standard tungsten filament lamp is described.

This calibration included a study of the intermittency effect at exposure times of the order of 0.02 μsec. Examples of the application of the instrument to the measurement of high temperatures produced by high explosives are given. The illustrations include temperature measurements of detonation fronts in explosives and explosively induced shock waves in air and argon. Also included are studies of "Mach Detonation Events" produced by converging ordinary detonation fronts, exploding bridge wires and high-energy spark and arc discharges.

Le principe et l'application d'un spectrographe séparateur de temps à grande vitesse

DONALD BAKER MOORE et JOHN K. CROSBY, Stanford Research Institute, Menlo Park, Californie

Les auteurs décrivent le principe et la construction d'un spectrographe séparateur de temps caractérisé par une résolution de temps de 0,02 μs et une résolution de longueur d'onde de 3 A. Cet instrument a été réalisé par la Beckman & Whitley Corp. pour les Laboratoires Poulter de l'Institut de Recherches Stanford en vue de son emploi dans l'étude des phénomènes relatifs aux explosifs puissants. L'article explique comment l'instrument a été étalonné en employant une lampe à filament de tungstène de type standard.

Cet étalonnage a comporté une étude de l'effet d'intermittence à des temps d'exposition de l'ordre de 0,02 μs. Il est donné des exemples de l'application de l'instrument à la mesure des températures élevées produites par les explosifs puissants. Parmi ces exemples figurent des mesures de température des fronts de détonation dans les explosifs et des ondes de choc provoquées explosivement dans l'air et l'argon. L'article traite aussi d'études de "processus de détonation Mach" produits par des fronts de détonation convergents du type usuel, par des fils de pont explosants et par des décharges d'étincelle ou d'arc à haute énergie.

Entwurf und Anwendung eines Hochgeschwindigkeits-Zeitauflösenden Spektrographen

DONALD BAKER MOORE und JOHN K. CROSBY, Stanford Research Institute, Menlo Park, Kalifornien

Es wird der Entwurf und der Bau eines Zeitauflösungs- Spektrographen beschrieben, der eine Zeitschärfe von 0,02 Mikrosekunden und eine Wellenschärfe von 3 A besitzt. Das Instrument wurde von der Beckman and Whitley Corp. für die Poulter Laboratories des Stanford Research Institute zur Verwendung bei der Untersuchung von Spregstofferscheinungen gebaut. Das Instrument wird unter Verwendung einer Wolframfaden-Normallampe kalibriert.

Zu dieser Kalibrierung gehört auch eine Untersuchung des Intermittenzeffekts bei Belichtungszeiten um 0,02 Mikrosekunden. Es werden Beispiele für die Anwendung des Geräts zum Messen hoher Temperaturen gegeben, die von Sprengstoffen erzeugt werden. Die Abbildungen zeigen Temperaturmessungen von Detonationsfronten in Sprengstoffen und explosiv angeregte Stosswellen in Luft und Argon. Auch sind Untersuchungen enthalten über "Mach Detonations-Vorfälle," die die durch konvergierende gewöhnliche Detonationsfronten, explodierende Brückendrähte und Hochenergie-Funken – und Lichtbogenentladungen hervorgerufen wurden.

High-Speed Spectroscopic Instruments

FRANCIS D. HARRINGTON, U.S. Naval Research Laboratory, Washington, D. C.

The Radiometry I Branch, Optics Division, U.S. Naval Research Laboratory, has been engaged for a number of years in research on rapidly occurring phenomena. Most of the work was performed as part of a project initiated and supported by the Los Alamos Scientific Laboratory of the University of California. The spectroscopic phase of this work required the development of many unusual dynamic high-speed spectrographs having a wide variety of time resolutions, wavelength resolutions, and wavelength coverages. There are three general types of time-resolving spectrographs: (1) moving-film: (2) rotating-drum; and (3) rotating-mirror.

Two moving-film-type instruments were developed: the *f*/6.6 Cine High-Speed Prism Spectrograph produces 4000 framed low-dispersion spectra per second for the ultraviolet and visible regions; and the N4GS *f*/2.8 Grating Spectrograph, modified from the Cine, to record low-dispersion streak spectrograms in the visible region. The maximum time resolution of the latter instrument is 1.0 μsec. The MK55 High-Speed Ultraviolet Spectrograph is a rotating-drum medium-dispersion instrument with a time resolution of 0.1 μsec. It was designed and built for NRL by the University of Rochester. The *f*/6.6 102 Prism Streak and the *f*/7.5 N9GS Grating Spectrographs are rotating-mirtor-type instruments. The 102 is a low-dispersion instrument for the ultraviolet and visible regions and the N9GS is a high-dispersion spectrograph for the visible region. Both of these spectrographs have a maximum time resolution of 0.01 μsec.

Des instruments spectroscopiques à grande vitesse

FRANCIS D. HARRINGTON, U.S. Naval Research Laboratory, Washington, D.C.

La Branche de Radiométrie I de la Division Optique du Laboratoire des Recherches Navales des Etats-Unis se livre, depuis un certain nombre d'années, à des recherches sur les phénomènes à processus rapide. La plupart de ces travaux ont été effectués en exécution d'un projet institué et patroné par le Laboratoire Scientifique Los Alamos de l'Université de Californie. La phase spectroscopique de ces travaux a nécessité la création de nombreux spectrographes dynamiques de grande vitesse et de type spécial caractérisés par une grande variété de résolutions de temps, de résolutions de longueur d'onde et de gammes de longueurs d'onde. On distingue trois types généraux de spectrographes à résolution de temps: (1) à film cinématographique, (2) à tambour tournant et (3) à miroir tournant.

Deux instruments du type à film cinématographique ont été perfectionnés, à savoir d'une part le spectrographe à prisme et à grande vitesse Ciné de *f*/6,6 qui produit 4000 images spectrales à faible dispersion par seconde pour la zone ultraviolette et les régions visibles, et d'autre part le spectographe à réseau NIGS de *f*/2,8 qui est une modification du modèle Ciné conçue pour enregistrer des spectrogrammes à stries et à faible dispersion dans la région visible. La résolution maximum de temps de ce dernier instrument est de 1,0 μs. Le spectrographe ultraviolet à grande vitesse MK55 est un instrument à dispersion moyenne du type à tambour tournant qui a une résolution de temps de 0,1 μs. Il a été concu et réalisé pour NRE par l'Université de Rochester. Le spectrographe à stries et prisme No. 102 de *f*/6,6, ainsi que le spectrographe à réseau N9GS de *f*/7,5 sont des instruments du type à miroir tournant. Le modèle 102 est un instrument à faible dispersion pour la zone ultraviolette et les régions visibles, alors que le type N9GS est un spectrographe à haute dispersion pour la région visible. L'un et l'autre de ces spectrographes ont une résolution maximum de temps de 0,01 μs.

Spektrographische Hochgeschwindigkeits-Instrumente

FRANCIS D. HARRINGTON, U.S. Naval Research Laboratory, Washington, D.C.

Die Stelle für Radiometrie I der optischen Abteilung des U.S. Naval Research Laboratory hat sich seit einer Anzahl von Jahren mit der Erforschung von schnell sich abspielenden Erscheinungen befasst. Der Grossteil der Arbeiten war der Teil eines Projektes, das vom Los Alamos Scientific Laboratory der University of California angeregt und unterstützt wurde. Die spektrographische Phase dieser Arbeiten erforderte die Ausbildung vieler ungewöhnlicher dynamischer Hochgeschwindigkeits-Spektrographen mit sehr verschiedenen Auflösungsstärken für Zeit und Wellenlänge und verschiedener Wellenlängenbereiche. Es gibt drei Haupttypen von zeitauflösenden Spektrographen: 1) kinematographische; 2) mit rotierender Trommel; 3) mit rotierendem Spiegel.

Es wurden zwei Apparate der kinematographischen Art entwickelt: der "Cine" Hochgeschwindigkeits-Prismenspektrograph 1:6,6 gibt 4000 Aufnahmen/s von Spektren geringer Dispersion für die ultravioletten und sichtbaren Gebiete; der NIGS Gitterspektrograph 1:2,8, eine Abänderung des Cine ist dazu bestimmt Schlierenspektrogramme geringer Dispersion in der sichtbaren Zone aufzunehmen. Die grösste Zeitauflösung des letzteren Instruments ist 1,0 Mikrosekunde. Der Hochgeschwindigkeits-Ultraviolett-Spektrograph MK 55 ist ein Apparat mit rotierender Trommel mittlerer Dispersion mit einer Zeitresolution von 0,1 Mikrosekunde. Es wurde von der University of Rochester für NRE entworfen und gebaut. Die beiden folgenden Apparate, der 1:6,6 Nr. 102 Prismen-Schlieren- und der 1:7,5 N9GS Gitterspektrograph besitzen rotierende Spiegel. Der 102 ist ein Gerät geringer Dispersion für die ultravioletten und sichtbaren Zonen und der N9GS Hochdispersions- Spektrograph für die sichtbare Zone. Beide dieser Spektrographen haben eine eine maximale Zeitresolution von 0,01 Mikrosekunde.

A Stereoscopic High-Speed Framing Camera Technique for the Study of Shaped-Charge Liner Collapse

BRADLEY O. REESE, Stanford Research Institute, Menlo Park, Calif.

The Beckman & Whitley Model 189 Framing Camera is used at a framing rate of 600,000/sec for this study. An external stereoscopic mirror arrangement places pairs of stereo images on the film plane. The shaped-charge liner is plated and marked with reference rings. It fires through a mirror at 45° into target material, thus providing simultaneous performance data. Since the effective shutter speed is $\frac{1}{4}$ μsec and the effective aperture is $f/14.5$, intense light from an argon-explosive bomb is needed. Photographic materials are pressed to the upper limit to obtain adequate exposures. Sharp definition and minimum background are required to make accurate measurements from enlargements of the images obtained.

The photo sequences are well suited for study with a stereo viewer for observation of detailed effects. Precise measurements for velocity profiles are made from cross-section plots reconstructed on a geometrical plotting device. The device projects the film images to a plotting screen; placing cross-hairs on corresponding points locates a point in space with a standard deviation of 0.08 mm. The liner collapse velocity obtained is then used in analyzing the jet formed by the shaped charge.

Une technique de caméra multi-images stéréoscopique à grande vitesse pour l'étude de l'affaissement des fourreaux à charge profilée

BRADLEY O. REESE, Stanford Research Institute, Menlo Park, Californie

Pour cette étude, la caméra multi-images Beckman & Whitley Modèle 189 s'emploie à une cadence d'images de 600.000/s. Un système de miroirs stéréoscopiques extérieurs place des paires d'images stéréo sur le plan du film. Le fourreau à charge profilée est garni de plaques et marqué avec des bagues-repères. L'appareil déclenche par l'entremise d'un miroir à 45° dans la matière de la cible, ce qui permet des observations de performance simultanées. Vu que la vitesse effective de l'obturateur est de 0,25 μs et que l'ouverture effective est de $f/14,5$, on a besoin de la lumière intense d'une bombe à explosif-argon. Les matières photographiques sont comprimées à la limite maximum afin d'obtenir des expositions satisfaisantes. Un maximum de netteté et un minimum d'arrière-plan sont nécessaires pour pouvoir effectuer des mesures précises à partir d'agrandissements des images obtenues.

Les séries de photos se prêtent bien à l'étude au moyen d'une stéréo-visionneuse pour l'observation des effets détaillés. Les mesures précises pour les profils de vitesse s'effectuent sur des tracés graphiques en coupe reconstruits sur un appareil de traçage géométrique. Cet appareil projette les images du film sur un écran de traçage; en plaçant des fils en croix aux points correspondants, on situe un point dans l'espace avec un écart normal de 0.08 mm. La vitesse d'affaissement du fourreau obtenue est alors utilisée pour analyser le jet formé par la charge profilée.

Eine Stereo-Hochgeschwindigkeits-Bildreihenkameramethode zur Untersuchung des Zusammenbruchs von Profil-Sprengladungen

BRADLEY O. REESE, Stanford Research Institute, Menlo Park, Kalifornien

Für die Untersuchungen wurde eine Beckman and Whitley Bildreihenkamera Modell 189 mit einer Bildgeschwindigkeit von 600,000 Aufnahmen/s verwendet. Eine aussen angebrachte stereoskopische Spiegelanordnung bringt Paare von Stereobildern auf die Filmfläche. Der profilierte Sprengstoffeinsatz ist plattiert und mit Markierringen versehen. Er feuert durch einen Spiegel bei 45° in ein Zielmaterial und liefert daher gleichzeitige Leistungsdaten. Da die wirksame Verschlussgeschwindigkeit $\frac{1}{4}$ Mikrosekunde und die wirksame Öffnung $1:14,5$ ist, benötigt man die intensive Beleuchtung einer Argon-Sprengstoffbombe. Um angemessene Belichtungen zu erzielen, werden die photographischen Materialien bis zu ihrer Leistungsgrenze beansprucht. Um an den Vergrösserungen der erzielten Bilder genaue Messungen vornehmen zu können, wird eine grosse Schärfe und geringster Hintergrund benötigt.

Die Bildreihen eignen sich sehr gut zur Beobachtung mit einem Stereo-Schaugerät, um Einzelheiten der Wirkung zu betrachten. Genaue Messungen für Geschwindigkeitsprofile werden nach Querschnittdiagrammen gemacht, die auf einem geometrischen Zeichengerät rekonstruiert werden. Diese Vorrichtung wirft das Filmbild auf einen Messchirm; durch Einstellen von Fadenkreuzen auf korrespondierende Punkte wird ein Punkt im Raum mit einer Normalabweichung von 0,08 mm festgelegt. Die Geschwindigkeit des Zusammenbruches des Einsatzes wird dann bei der Analypierung des von der profilierten Sprengladung gebildeten Strahls verwendet.

High-Speed Photographic Recording of Dual Data at High Magnification

B. H. AMSTEAD, The University of Texas, Austin, Tex.

This paper describes a technique whereby two or more physically contrasting types of data may be recorded simultaneously and in concord on a single strip of film at camera speeds in excess of 4000 frames/sec. The physical image of the photographed subject is recorded on film in the conventional manner employed in high-speed motion-picture techniques, but in addition to this image, a second physical characteristic of the system may be recorded as a moving spot of light on the film. This spot of light moves according to instructions it receives from an amplified electronic signal originating from a strain gage, piezoelectric crystal or similar type high-response rate detection device. As a result of this technique at least two types of discrete data may be recorded at speeds of over 3000 times/sec over a short time interval.

L'enregistrement photographique à grande vitesse de données doubles avec haute amplification

B. H. AMSTEAD, The University of Texas, Austin, Texas

Le présent article décrit une technique selon laquelle deux ou plusieurs types physiquement contrastants de données peuvent être enregistrés simultanément et en concordance sur une bande unique de film à des vitesses de caméra supérieures à 4000 images/sec. L'image physique du sujet photographié est enregistrée sur film de la manière couramment employée dans les techniques cinématographiques à grande vitesse, mais en plus de cette image, une deuxième caractéristique physique du système peut être enregistrée sous forme d'un point lumineux mobile sur le film. Ce point lumineux se déplace suivant les instructions qu'il reçoit d'un signal électronique amplifié émanant d'un cristal piézo-électrique à indicateur de réaction ou d'un appareil détecteur similaire à réaction élevée. Par le moyen de cette technique, on peut enregistrer au moins deux types de données distinctes à des vitesses de plus de 3000/sec pendant un court intervalle de temps.

Photographische Hochgeschwindigkeitsaufnahme verschiedener Daten bei starker Vergrösserung

B. H. AMSTEAD, The University of Texas, Austin, Texas

Dieser Artikel beschreibt eine Methode, nach der zwei oder mehrere physisch verschiedene Arten von Daten gleichzeitig und gemeinsam auf einem einzigen Filmstreifen mit Bildfrequenzen von über 4.000 Aufnahmen/s aufgenommen werden können. Das physische Bild des zu photographierenden Objekts wird am Film nach den in der Hochgeschwindigkeits - Kinematographie üblichen Methoden aufgenommen; zusätzlich zu diesem Bild wird jedoch noch eine zweite physikalische Eigenschaft der Objektanlage als beweglicher Lichtpunkt am Film registriert. Dieser Lichtpunkt bewegt sich nach Weisungen, die er von einem verstärkten elektronischen Zeichen erhält, das von einem Spannungsmesser, einem piezoelektrischen Kristall oder von einem ähnlichen Gerät hoher Reaktionsgeschwindigkeit gegeben wird. Nach dieser Methode lassen sich wenigstens zwei Arten von Angaben für eine kurze Zeitperiode mit Geschwindigkeiten von über 3.000 mal/s aufnehmen.

High-Speed Motion-Picture Photography of Microscopic Phase Changes

J. E. BENJAMIN and J. W. WESTWATER, Division of Chemical Engineering, University of Illinois, Urbana, Ill.

A desire to study the growth of microscopic bubbles during nucleate boiling led to the use of high-speed photography. Development of the techniques for providing sufficient illumination to photograph at high speed with high magnification while minimizing vibration of the equipment led to the present apparatus. Usable motion pictures have been obtained at 6000 frames/sec

La photographie cinématographique à grande vitesse des changements de phases microscopiques

J. E. BENJAMIN et J. W. WESTWATER, Division of Chemical Engineering, University of Illinois, Urbana, Ill.

On s'est adressé à la photographie à grande vitesse pour étudier la croissance des bulles microscopiques pendant l'ébullition nucléaire. L'appareil réalisé incorpore des techniques spéciales qui visent à assurer un éclairement suffisant pour photographier à grande vitesse avec forte amplification, tout en réduisant au minimum les vibrations de l'équipement. On a obtenu des

Hochgeschwindigkeits-Kinematographie von Mikroskopischen Änderungen in Verschiedenen Phasen

J. E. BENJAMIN und J. W. WESTWATER, Division of Chemical Engineering, University of Illinois, Urbana, Ill.

Der Wunsch, das Wachsen mikroskopischer Bläschen während des nuklearen Kochens studieren zu können, führte zum Gebrauch der Hochgeschwindigkeits-Photographie. Durch Ausbildung der Methoden zur Erzielung genügender Beleuchtung für die Photographie mit hoher Geschwindigkeit und starker Vergrösserung—dabei mit möglichst geringer Vibration

with a 66× enlargement of the image on the 16mm negative.

A Wollensak Fastax WF-15 camera with Goose controls and 1000-cycle signal generator was employed. The camera viewed through a metallographic microscope mounted horizontally and aimed through a thin glass window in the test cell. The magnification on the film was varied from 3× to 66× by varying the eyepieces and objectives and by adjusting the distance between the microscope and the camera. Arc illumination was from 10-mm rare-earth cored carbons operating at 30 amp. All equipment was mounted on railroad rails cast in concrete. The apparatus is a powerful tool for phenomena which are rapid and interesting from the microscopic viewpoint. It is used now for studies of dropwise condensation, bubble growth during electrolysis, bubble growth from gases dissolved in liquids, the melting of solids, and the freezing of liquids.

films cinématographiques utilisables à des cadences de 6000 images/s avec un agrandissement de 66 fois de l'image sur le négatif de 16mm.

On a utilisé une caméra Wollensak Fastax WF-15 avec commandes Goose et générateur de signaux de 1000 cycles. La caméra a pris les vues par l'entremise d'un microscope métallographique monté horizontalement et a visé à travers une fenêtre à verre mince ménagée dans la cellule d'essai. On a fait varier l'amplification sur le film de 3 à 66 fois en modifiant les oculaires et les objectifs et en réglant la distance entre le microscope et la caméra. L'éclairage à l'arc a été obtenu au moyen de charbons à noyau en terres rares de 10 mm fonctionnant à 30 amp. Tout l'équipement était monté sur des rails de chemin de fer coulés dans le béton. L'appareil est un puissant instrument pour étudier les phénomènes rapides qui présentent un intérêt au point de vue microscopique. Il est employé actuellement pour les études de la condensation en gouttes, de la croissance des bulles pendant l'électrolyse, du développement de bulles provenant de gaz dissous dans les liquides, de la fusion des solides et de la congélation des liquides.

der Geräte—führte zu dem gegenwärtigen Apparat. Es wurden auf einem 16 mm Negativ brauchbare kinematographische Bilder mit 6000 Aufnahmen/s und einer 66fachen Bildvergrösserung erzielt.

Man benützte eine Wollensak Fastax WF-15 Kamera mit Goose Regler und einem 1000 Hertz Signalgenerator. Die Kamera photographierte durch ein metallographisches Mikroskop, das horizontal angeordnet war, und wurde durch ein dünnes Glasfenster in der Versuchszelle gerichtet. Die Vergrösserung am Film zwischen 3fach und 66fach wurde dadurch geändert, dass man sowohl Okulare und Objektive wie auch die Entfernung zwischen Mikroskop und Kamera änderte. Die Lichtbogenbeleuchtung kam von 10 mm Kohlestäben mit Seelen aus seltenen Erden, die mit 30 A arbeiteten. Die ganze Apparatur wurde auf in Beton eingebetteten Eisenbahnschienen aufmontiert. Die Einrichtung ist ungemein wichtig für Phänomene die sich rasch abspielen und vom mikroskopischen Standpunkt aus interessant sind. Sie wird jetzt dazu verwendet, die tropfenweise Kondensation, Bläschenentstehung während der Elektrolyse, sowie aus in Flüssigkeiten gelösten Gasen, das Schmelzen von festen Körpern und das Frieren von Flüssigkeiten zu studieren.

High-Speed Stereoscopic Motion-Picture Photography by Means of the CΦP Type of Camera

V. V. Garnov and A. S. Dubovik, Institute of Chemical Physics, Academy of Sciences of the USSR, Moscow

(To be presented by title only)

Cinématographie stéréoscopique à grande vitesse avec la caméra CΦP

V. V. Garnov et A. S. Dubovik, Institut de la Physique Chimique, Académie des Sciences de l'URSS, Moscou

Hochfrequenz-Stereophotographie mit der CΦP-Kamera

V. V. Garnov und A. S. Dubovik, Institut der chemischen Physik, Akademie der Wissenschaften der UdSSR, Moskau

——— WEDNESDAY 8:00 P.M. ENTERTAINMENT — Floor Show

OCTOBER 20 — THURSDAY 9:00 A.M. SESSION: Cameras — Sweep and Streak .....

An f/1 Streak Camera for Use in the Ultraviolet

J. Dyson, R. F. Hemmings and R. T. Waters, Associated Electrical Industries Ltd., Aldermaston, Berks, England

The electrical breakdown under surges of large air gaps is accompanied by high-speed low-luminosity processes which can be studied by high-speed photography. Suitable records can only be obtained by a system with good time resolution, high aperture and ultraviolet transparency, and by suppression of the discharge before the final brilliant arc phase. A camera with a rotating mirror driven directly by a high-speed motor has been constructed for this purpose. The optical system uses reflection only (save for a silica vacuum window) and has an aperture of f/1. The focal surface is curved, and a technique for moulding film to the required curvature has been developed.

Reference points superimposed on the image to define the time axis, gap axis and resolving speed enable time estimates of 10^{-8} sec to be achieved. The structure and rate of development of sparks in gaps of up to 2 m have been examined. In particular it is shown that the visible progress of the spark leader is in discontinuous steps in close analogy with the lightning "first-leader" stroke recorded by the Boys' camera.

Une caméra à stries de f/1 conçue pour l'ultraviolet

J. Dyson, R. F. Hemmings et R. T. Waters, Associated Electrical Industries Ltd., Aldermaston, Berks, Angleterre

La panne électrique qui se produit sous les afflux des grands entrefers est accompagnée de processus à faible luminosité et grande vitesse qu'on peut étudier au moyen de la photographie à grande vitesse. Des enregistrements satisfaisants ne peuvent s'obtenir qu'au moyen d'un système caractérisé par une bonne résolution de temps, une forte ouverture et une transparence ultraviolette, et par la suppression de la décharge avant la phase finale d'arc brillant. On a construit à cette fin une caméra munie d'un miroir tournant actionné directement par un moteur à grande vitesse. Le système optique utilise seulement la réflexion (sauf une fenêtre à vide en silice) et a une ouverture de f/1. La surface focale est courbée et l'on a perfectionné une technique spéciale pour mouler le film à la courbure appropriée.

Des points de repère superposés sur l'image pour définir l'axe des temps, l'axe des entrefers et la vitesse de résolution permettent d'obtenir des évaluations de temps de 10^{-8} s. On a examiné la structure et la rapidité de production des étincelles dans des entrefers allant jusqu'à 2 mètres. En particulier, on démontre que le progrès visible de la pointe de l'étincelle s'effectue par phases discontinues présentant une très grande analogie avec "l'éclair de pointe" du coup de foudre enregistré au moyen de la caméra Boys.

Eine 1:1 Schlierenkamera für den Gebrauch im Ultraviolett

J. Dyson, R. F. Hemmings und R. T. Waters, Associated Electrical Industries Ltd., Aldermaston, Berks, England

Die elektrische Entladung unter den durch weite Luftspalten verursachten Stromstössen wird von Vorgängen hoher Geschwindigkeit und geringer Luminosität begleitet, die sich mittels Hochgeschwindigkeits-Photographie untersuchen lassen. Zweckmässige Aufnahmen können durch eine Anlage erzielt werden, die gute Zeitresolution, grosse Öffnung und ultraviolette Durchsichtigkeit besitzt und dadurch, dass die Entladung unterdrückt wird bevor sie die Endphase des hellen Lichtbogen erreicht. Es wurde für diesen Zweck eine Kamera mit rotierendem Spigel gebaut, der direkt durch einen Hochgeschwindigkeitsmotor angetrieben wird. Das optische System gebraucht nur Reflexion (ausgenommen ein Silikat-Vakuumfenster) und hat eine Öffnung von 1:1. Die Bildebene ist gebogen und es wurden Wege ermittelt um den Film zu der entsprechenden Kurve zu formen.

Durch das Uberlagern von Bezugspunkten auf das Bild ist es möglich die Zeitachse, Luftspaltachse und Resolutions-geschwindigkeit festzustellen und dadurch Zeitschätzungen von 10^{-8} Sekunde zu erzielen. Es wurde die Struktur und die Entwicklungsgeschwindigkeit von Funken bis zu 2 m untersucht. Es wurde auch gezeigt dass der sichtbare Fortschritt des Funkenvorläufers in nicht-kontinuierlichen Stufen erfolgt, fast analog dem "Vorläufer" Blitzschlag der mit der Boys Kamera aufgenommen wurde.

Streak Camera Development by The National Research Council

E. H. Dudgeon, Gas Dynamics Section, National Research Council, Ottawa, Canada

Two streak cameras have been developed by the National Research Council for use in various studies of high-speed gas phenomena. In the design of both cameras the emphasis is on simplicity without sacrificing performance or convenience of operation. Both cameras can be manufactured without the use of special high-precision machine tools or testing equipment. For photographing high-speed phenomena a rotating-mirror camera has been developed. The rotating mirror is mounted on hydrostatic air bearings and is driven by a radial-flow air turbine to avoid any contamination of the film or mirror by oil mist.

Film loading and unloading can be done in normal light and the camera may be operated in any position. The maximum film writing speed is 5mm/μsec. The present lens system provides an effective aperture of *f*/14. An electronic speed detector and control unit has been incorporated to trigger the event when the mirror is in the correct position for photographing. For use where lower film writing speeds are adequate, or where synchronization with the event is not feasible, a compact air-bearing rotating-drum camera has also been developed.

Une réalisation de caméra à stries par le National Research Council

E. H. Dudgeon, Gas Dynamics Section, National Research Council, Ottawa, Canada

Deux caméras à stries ont été réalisées par le Conseil National de Recherches en vue de leur utilisation dans diverses études de phénomènes gazeux à grande vitesse. La construction de ces deux caméras se signale par sa grande simplicité, sans qu'onn'ait rien sacrifié en rendement ou en commodité de fonctionnement. Les deux appareils peuvent être fabriqués sans devoir employer de machines-outils spéciales de grande précision ou d'équipement d'essayage délicat. Pour photographier les phénomènes très rapides, on a perfectionné une caméra à miroir tournant. Ce miroir tournant est monté sur des aéropaliers hydrostatiques et est actionné par une turbine à air du type à débit radial afin d'éviter toute contamination du film ou du miroir par un brouillard d'huile.

Le chargement et le déchargement du film peuvent être effectués à la lumière normale et l'on peut faire fonctionner la caméra dans n'importe quelle position. La vitesse maximum d'enregistrement du film est de 5 mm/μs. Le système d'objectif actuel comporte une ouverture effective de *f*/14. Un détecteur électronique de vitesse avec organe de commande a été incorporé à l'appareil afin de déclencher le cycle opératoire dès que le miroir est dans la position appropriée pour la prise de vues. Pour les emplois ou des vitesses d'enregistrement de film plus faibles suffisent, ou pour les cas d'impossibilité de synchronisation avec le processus, on a aussi réalisé une caméra de faible encombrement à tambour tournant et aéro-paliers.

Neue Schlierenkameras von dem National Research Council

E. H. Dudgeon, Gas Dynamics Section, National Research Council, Ottawa, Kanada

Der National Research Council hat zwei neue Schlierenkameras entwickelt um verschiedene Untersuchungen von Hochgeschwindigkeits-Phänomenen in Gasen vorzunehmen. Beim Entwurf beider Kameras wurde besonderes Gewicht auf einfachen Bau gelegt ohne die Leistung oder die Einfachheit der Bedienung zu verringern. Beide Kameras können ohne den Gebrauch von Werkzeugmaschinen oder Prüfgeräten besonders hoher Präzision hergestellt werden. Um Hochgeschwindigkeits-Phänomene zu photographieren wurde eine Kamera mit rotierendem Spiegel ausgearbeitet. Dieser Spiegel ist auf hydrostatischen Luftlagern angebracht und wird durch eine Radialfluss-Luftturbine angetrieben, um jede Verschmutzung des Films oder des Spiegels durch Ölnebel zu vermeiden.

Der Film kann bei gewöhnlichem Licht eingesetzt oder herausgenommen werden und die Kamera kann in jeder Lage betätigt werden. Die maximale Filmaufnahmegeschwindigkeit ist 5mm/Mikrosekunde. Das gegenwärtige Linsensystem gibt eine wirksame Öffung von 1:14. Es wurde eine elektronische Einheit für Messung und Regelung der Geschwindigkeit eingebaut, um das Objektereignis auszulösen, sobald der Spiegel in der zur Aufnahme geeigneten Lage ist. Für Zwecke wo eine geringere Geschwindigkeit genügt oder eine Synchronisierung mit dem Ereignis unmöglich ist, wurde eine Kamera entwickelt, die kompakt ist und eine luftgelagerte rotierende Trommel besitzt.

The Improved f/10 Sweeping-Image Camera: A Versatile Model for Explosive Research

Berlyn Brixner, Los Alamos Scientific Laboratory, University of California, Los Alamos, N. M.

The previously described *f*/10 sweeping-image camera has been equipped with a series of refined accessories to adapt it for a wide variety of explosive research problems. In order that the camera may be used with an assortment of objective lenses, it has been equipped with the following adjustable accessories: camera and lens mounts, demountable lenses, remote-control focusing, slit holder mount, field lens mount, and viewfinder. Attachments which help in obtaining the correct relative adjustment between the object and the final image are an illuminated-slit projector, a precision mount for the astigmatism correcting lens, and a sweeping-image viewer. To safeguard personnel in the event of a mirror explosion during camera operation, an armor plating has been installed. This work was done under the auspices of the U.S. Atomic Energy Commission.

La camera à fente *f*/10 améliorée: un modèle versatile pour la recherche sur les explosions

Berlyn Brixner, Los Alamos Scientific Laboratory, University of California, Los Alamos, N.M.

La camera à fente *f*/10 que nous avons décrite dans un autre article, a été équippée avec une succession d'accessoires raffinés qui permettent de l'adapter à une grande diversité de problèmes de recherche sur les explosions. Pour que la camera soit employable avec un assortiment de lentilles, elle a été outillée avec les accessoires réglables suivants: des montures de caméra et de lentille, des lentilles démontables, une commande à distance de la mise au point, une monture de la fente, une monture de la lentille du champ, et un viseur. Les accessoires qui aident à obtenir l'ajustement relatif exact entre l'objet et l'image finale sont un projecteur pour illuminer la fente, une monture de précision pour la lentille qui corrige l'astigmatisme, et un appareil à examiner l'image de la fente balayante. Et pour protéger le personnel en cas d'une explosion du miroir pendant que la caméra travaille, on a installé une armature protectrice.

Die verbessert 1:10 Schlitzkamera: ein vielseitiges Modell für Explosionsforschung

Berlyn Brixner, Los Alamos Scientific Laboratory, University of California, Los Alamos, N.M.

Die früher beschriebene 1:10 Schlitzkamera wurde mit einer Anzahl verfeinerter Zubehörteile versehen um sie für verschiedene Probleme der Explosionsforschung zu adaptieren. Für den Gebrauch der Kamera mit verschiedenen Objektiven sind folgende einstellbare Zubehörteile vorgesehen: Kamera- und Linsenfassungen, auswechselbare Linsen, eine ferngesteuerte Einstellung, Schlitzhalter- und Feldlinsenfassungen, und Sucher. Zubehörteile für richtige relative Einstellung zwischen dem Objekt und dem Endbild sind ein Projektor für den beleuchteten Schlitz, eine feinmechanische Fassung für die Astigmatismus-Ausgleichslinse, und ein Streifenbildsucher. Aus Sicherheitsgründen, im Falle einer Drehspiegelexplosion, wurde eine Panzerplatte eingesetzt.

A High-Speed Rotating Mirror With Greater Dynamic Resolution

Willard E. Buck, Consultant on Instrumentation and High-Speed Cameras, Boulder, Colo.

Increased dynamic resolution is possible with a newly designed turbine-driven rotating mirror. This is accomplished by eliminating the air turbulence around the rotating mirror by operating it in an evacuated camera; and by the use of a beryllium mirror that has exceedingly low dynamic distortion. Additional advantages derived from an evacuated camera are: (1) light from the vacuum ultraviolet may be used to increase overall light flux; (2) the mirror may be run to its bursting speed with an air drive with no helium required and (3) size of air-supply equipment is reduced, making semiportable setup practical.

Un miroir tournant de grande vitesse à résolution dynamique élevée

Willard E. Buck, expert-conseil en instruments et caméras à grande vitesse, Boulder, Colorado

Un nouveau type de miroir tournant actionné par turbine a permis d'en accroître la résolution dynamique. Ce résultat a été obtenu en éliminant la turbulence d'air autour du miroir tournant en le faisant fonctionner dans une caméra où l'on a fait le vide et en utilisant un miroir en béryllium caractérisé par une distorsion dynamique extrêmement faible. Parmi les autres avantages de cette caméra du type à vide, il faut encore citer les suivants: (1) la lumière qui émane de l'ultraviolet dans le vide peut être utilisée pour accroitre le flux lumineux total; (2) le miroir peut tourner à sa vitesse maximum avec une commande pneumatique sans nécessiter d'hélium;

Ein rotierender Hochgeschwindigkeits spiegel mit grösserer dynamischer Resolution

Willard E. Buck, Beratender Ingenieur für Instrumente und Hochgeschwindigkeits-Kameras, Boulder, Colorado

Ein neuer turbinenbetriebener rotierender Spiegel ermöglicht bessere dynamische Resolution. Dies geschieht dadurch, dass die um den rotierenden Spiegel herum entstehenden Luftwirbel ausgeschaltet werden indem man ihn in einer evakuierten Kamera betätigt, anderseits auch durch Benützung eines Berylliumspiegels, der eine ausserordentlich geringe dynamische Verzerrung hat. Die evakuierte Kamera besitzt auch noch folgende weitere Vorteile: 1) Man kann Licht aus dem Vakuum- Ultraviolett verwenden um die Gesamtlichtzufuhr zu erhöhen; 2) Der Spiegel kann mit Luftantrieb

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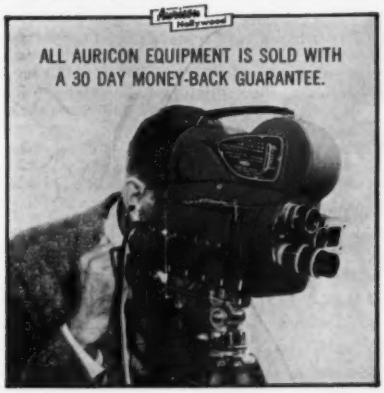

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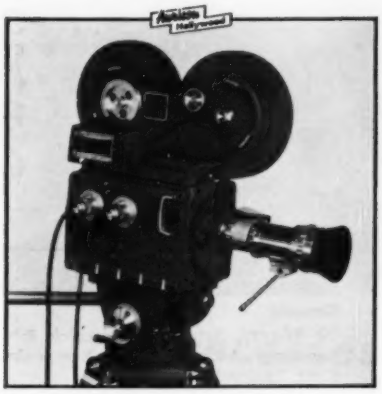

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For more convenient operation the new design also includes a built-in oil pump that pressurizes and circulates the oil for the bearings and vacuum seal; a magnetic pickup with a phase adjustable output for precise timing of controlled events; and a vacuum seal between turbine and mirror permitting the camera to be evacuated. A cross-section drawing showing construction details and a set of operating characteristics are presented.

et (3) l'équipement d'alimentation d'air est de faible encombrement, ce qui permet d'avoir un ensemble mi-portatif.

Pour plus de commodité dans le fonctionnement, le nouveau système comprend aussi une pompe à huile incorporée qui pressurise et fait circuler l'huile pour les paliers et pour le joint d'étanchéité à vide, un capteur magnétique à débit ajustable de phase permettant le réglage précis des processus contrôlés, et un joint à vide entre la turbine et le miroir afin de pouvoir faire le vide dans la caméra. L'auteur présente un dessin en coupe montrant les détails de construction et indique une série complète des caractéristiques de fonctionnement.

bis zu seiner Berstgeschwindigkeit betrieben werden ohne dass Helium benötigt wird; 3) die Grösse der Ausrüstung für Luftzufuhr wird herabgesetzt, so das seine semi-portable Anordnung möglich wird.

Zwecks einfacherer Bedienung hat der neue Entwurf auch eine eingebaute Ölpumpe vorgesehen, die das Öl unter Druck setzt und zirkuliert, das für die Lager und den Vakuumabschluss dient; weiters ein magnetisches Aufnahmegerät mit phasenadjustierbarer Leistung zum genauen Einstellen regelbarer Vorgänge; schliesslich einen Vakuumabschluss zwischen Turbine und Spiegel zur Evakuation der Kamera. Es wird eine Querschnittszeichnung und eine Liste von Betriebscharakteristiken gegeben.

VFK-ÚVOJM High-Speed Drum Camera

JAN HAMPL, Meopta Optics & Fine Mechanics Research Institute, Prerov, Czechoslovakia

This paper describes the principles and performance of a double-drum camera, taking shots at frequencies from 6000 to 42,000 frames/sec. Relative aperture of the camera is *f*/7, the total run 1304 frames measuring by 5 by 8 mm, and the resolving power 80 lines/mm. Specimen pictures taken at the maximum rate are included. (*To be presented by title only.*)

VFK-ÚVOJM—Une nouvelle caméra à tambour double

JAN HAMPL, Institut de Recherches Optiques et Mécaniques Meopta, Prerov, Czécoslovaquie

L'article explique les principes de construction et le fonctionnement d'une caméra à tambour double dont la fréquence de prises de vue varie de 6.000 à 42.000 images/sec. L'aperture relative est de f/7, le nombre maximum d'images 1304 d'une largeur de 5 x 8 mm, et la résolution s'étend à 80 lignes/mm. Des exemples de vues prises à la fréquence maximum seront présentés.

VFK-ÚVOJM Hochgeschwindigkeits-Trommelkamera

JAN HAMPL, Forschungsinstitut für Optik und Feinmechanik, Meopta, Prerov, Tschechoslowakei

Der Artikel beschreibt die Prinzipien und Operation einer Doppeltrommelkamera deren Bildfrequenz zwischen 6.000 und 42.000 liegt. Die Kamera hat eine relative Apertur von 1,7; gibt 1304 Bilder von einer Grösse von 5 x 8 mm und eine Auflösungsfeinheit von 80 Linien/mm. Einige Beispiele von Bildern, die zur höchsten Frequenz genommen wurden, werden beigefügt.

—— THURSDAY 10:45 A.M. SESSION: Cameras — Rotating-Mirror Smear.....

The CORE Camera: Continuous Receptivity — One Rotating Element

J. N. WHYTE, Armament Research & Development Establishment, Sevenoaks, Kent, England

The advantages of a streak camera having continuous receptivity and employing only one rotating element are discussed. The essential element of such a camera is a prism-mirror combination which is rotated at high speed. Various arrangements of this combination are possible and have been investigated with a view to compensating for the aberrational and "splitting" effects. The theory of image formation through the combination is reviewed and alternative schemes are discussed.

La caméra CORE: Réceptivité continue — Un seul élément tournant

J. N. WHYTE, Armament Research & Development Establishment, Sevenoaks, Kent, Angleterre

L'auteur examine les avantages d'une caméra à stries ayant une réceptivité continue et n'utilisant qu'un seul élément tournant. L'élément essentiel d'une telle caméra est une combinaison prisme-miroir qui est animée d'un mouvement de rotation rapide. Divers arrangements de cette combinaison sont possibles et ont été étudiés dans le but de compenser les effets d'aberration et de "dédoublement." L'auteur explique aussi la théorie de la formation de l'image par ladite combinaison et décrit en outre des variantes de ce système.

Die CORE Kamera: kontinuierliche Aufnahmefähigkeit—ein rotierendes Element

J. N. WHYTE, Armament Research & Development Establishment, Sevenoaks, Kent, England

Es werden die Vorteile einer Schlierenkamera mit kontinuierlicher Aufnahmefähigkeit und nur einem rotierenden Element erörtert. Der Hauptbestandteil einer solchen Kamer ist eine Kombination von Prisma und Spiegel, die mit grosser Geschwindigkeit rotiert. Es sind verschiedene Anordnungen dieser Kombination möglich und sie wurden im Hinblick auf die Möglichkeit der Kompensation für Aberrations- und "Spalt"-effekte untersucht. Es wird die Theorie der Bildformung durch die Kombination behandelt und es werden alternative Pläne erörtert.

A New Ultra-High-Speed Framing Camera Combining a Rotating Mirror With a Film Drum

TSUNEYOSHI UYEMURA, University of Tokyo, Chiba City, Japan

This paper describes a new framing camera combining an ultra-high speed rotating four-face mirror with a low-speed rotating film drum. Features include: continuous writing system, 100,000 frames/sec framing rate, 200 exposures per run, 1 μsec minimum exposure time, 75,000 rpm rotating-mirror motor drive, 900 rpm rotating film drum motor drive, effective aperture *f*/9. Exposure time can be maintained at the minimum value and 200 exposures per run, operating at low framing rate.

Une nouvelle caméra multi-images de type ultra-rapide à combinaison de miroir tournant et de tambour de film

TSUNEYOSHI UYEMURA, Université de Tokyo, Chiba, Japon

Le présent mémoire décrit une nouvelle caméra multi-images qui combine un miroir tournant à quatre faces de vitesse ultra-grande à un tambour rotatif de film de faible vitesse. Elle possède les caractéristiques suivantes: un système d'enregistrement continu, une cadence de 100.000 images/s, 200 expositions par série, un temps d'exposition minimum de 1 μs, une commande à moteur du miroir tournant de 75.000 t/m, une commande à moteur du tambour rotatif de film de 900 t/m et une ouverture effective de *f*/9. Le temps d'exposition peut être maintenu à la valeur minimum et 200 expositions par série en faisant fonctionner l'appareil à une faible cadence d'images.

Eine neue Höchstgeschwindigkeits-Bildreihenkamera kombiniert einen rotierenden Spiegel mit einer Filmtrommel

TSUNEYOSHI UYEMURA, University of Tokyo, Chiba City, Japan

Dieser Artikel beschreibt eine neue Bildreihenkamera, welche einen mit Höchstgeschwindigkeit rotierenden 4flächigen Spiegel mit einer langsam rotierenden Filmtrommel kombiniert. Zu den Merkmalen gehören folgende: kontinuierliche Aufnahme, Bildfrequenz 100.000/s, 200 Aufnahmen je Lauf, 1 Mikrosekunde Minimalbelichtungszeit, Rotationsspiegelantrieb 75.000 Umdrehungen/m, Motorantrieb der rotierenden Filmtrommel 900 Umdrehungen/m, wirksame Öffnung 1:9. Die Belichtungszeit kann bei ihrem Minimalwert und 200 Aufnahmen je Lauf beibehalten werden, auch wenn mit niedriger Bildfrequenz gearbeitet wird.

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Model 200, Reflecting-Optics, Sweep Camera

THURE ANDERSON, Radiation Laboratory, University of California, Livermore, Calif.

A sweep-image camera uses reflecting optics to achieve certain preselected performance characteristics: (1) high writing speed (30 to 60 mm/μsec); (2) *f*-number to produce image densities generally accepted on existing sweep cameras, *f*/8; (3) resolution compatible with film generally used, 70 lines/mm; (4) absence of chromatic abberation; and (5) rugged compactness. Two basic designs are discussed: one is a basic camera for infinity or near infinity use, having three reflecting components, an off-axis parabolic mirror objective, a flat "diagonal" mirror and the rotating mirror; and the other is a basic camera with external, independent objective, or telescope, for any distance, using spherical mirror off-axis with cylindrically corrected diagonal and rotating mirror.

A three-sided rotating mirror, with high length-to-diameter ratio is used, permitting a design speed of 32,000 rps, maximum. The stationary mirrors conform to the same aspect ratio as the rotor (approx. 6 : 1). The camera body is explosion proof and easily adapted to vacuum operation. 16mm film is used. The film support deviates from a true circle to provide constant overall optical path length. The camera is continuous "writing," each face "writing" 240 degrees with overlap to permit continuity with the following face, and thus need for synchronization with the recorded event is eliminated.

La caméra Modèle 200 à balayage et à système optique réfléchissant

THURE ANDERSON, Lawrence Radiation Laboratory, University of California, Livermore, Californie

Une nouvelle caméra à prise de vues par balayagt utilise les principes d'optique de réflexion pour réaliser certaines caractéristiques déterminées: (1) une grande vitesse d'enregistrement (30 à 60 mm/μs); (2) un indice-f choisi pour produire des densités d'image généralement acceptées sur les caméras à balayage en existence, à savoir *f*/8; (3) une résolution compatible avec le film généralement employé, à savoir 70 lignes/mm; (4) l'absence d'aberration chromatique; et (5) un faible encombrement allié à la robustesse. L'auteur décrit deux types de base de cet appareil: l'un est une caméra de base permettant une mise au point à l'infini ou au quasi-infini et ayant trois éléments réfléchissants, à savoir un objectif à miroir parabolique désaxé, un miroir plan en "diagonale" et un miroir tournant, alors que l'autre est une caméra de base à objectif extérieur indépendant out télescope, pour toute distance, qui utilise un miroir sphérique désaxé avec diagonale corrigée cylindriquement et miroir tournant.

Il est employé un miroir tournant à trois côtés de rapport longueur/diamètre élevé, ce qui permet une vitesse propre maximum de 32.000 t/s. Les miroirs fixes ont le même rapport d'allongement que l'élément tournant (environ 6:1). Le corps de la caméra est inexplosible et se prête au fonctionnement au vide. On emploie un film de 16mm. Le porte-film s'écarte d'un vrai cercle pour assurer une longueur constante de la course optique totale. La caméra est à "enregistrement" continu, chaque face "enregistrant" à 240° avec chevauchement pour assurer la continuité avec la face suivante et ainsi rendre inutile la synchronisation avec le processus enregistré.

Ablenkungskamera Modell 200 mit reflektierender Optik

THURE ANDERSON, Radiation Laboratory, University of California, Livermore, Kalifornien

Es handlet sich um eine "bildbestreichende" Kamera mit reflektierenden Optiken um gewisse im Voraus gewählte Leistungscharakteristiken zu erzielen: 1) hohe Aufnahmegeschwindigkeit (30 bis 60 mm/μs); 2) relative Öffnung um eine Bilddichte zu erzielen, die bei vorhandenen Ablenkungskameras allgemein annehmbar ist; sie ist 1:8; 3) eine Resolution die zum dem gewöhnlich gebrauchten Film passt, nämlich 70 Linien/mm; 4) Nichtvorhandensein chromatischer Aberration, und 5) solide Kompaktheit. Es werden zwei grundlegende Entwürfe besprochen: der einer grundlegenden Kamera für unendlich oder fast unendlich, mit 3 reflektierenden Bestandteilen, einem Parabolspiegelobjektiv abseits der Achse, einem flachen "diagonal"- Spiegel und dem rotierenden Spiegel. Die andere ist eine grundlegende Kamera mit äusserem unabhängigen Objektiv oder Teleskop für jede Distanz, die einen sphärischen, nicht in der Achse liegenden Spiegel mit zylindrisch korrigiertem Diagonal- und einem rotierenden Spiegel hat.

Es wird ein dreiseitiger rotierender Spiegel mit grossem Verhältnis zwischen Länge und Durchmesser verwendet, der entwurfsmässig eine Geschwindigkeit von 32.000 Umdrehungen/Sekunde maximal zulässt. Die stationären Spiegel haben das gleiche Formatverhältnis wie der Rotor, nämlich ungefähr 6:1. Der Körper der Kamera ist explosions sicher und leicht für Vakuumbetrieb einzurichten. Es wird 16 mm Film verwendet. Der Filmhälter weicht vom genauen Kreis ab um eine konstante optische Pfadlänge zu ermöglichen. Die Kamera registriert kontinuierlich und jede Seite nimmt 240 Grade mit einem Übergreifen das die Kontinuität mit der nachfolgenden Seite erlaubt, so dass eine Synchronisierung mit dem aufgenommenen Vorgang überflüssig ist.

Smear Camera Techniques

T. P. LIDDIARD, JR., and B. E. DRIMMER; U.S. Naval Ordnance Laboratory White Oak, Silver Spring, Md.

Various techniques have been developed at the Naval Ordnance Laboratory and other laboratories which greatly increase the usefulness of the rotating-mirror smear camera. When self-luminosity is insufficient, several methods are used to enhance the light, e.g. Scotch tape on explosive surfaces, air or argon gaps, a layer of microballoons, etc. When required, external light is supplied by exploding wires, explosive flashlamps, etc. Light reflected from the surface of opaque materials is used to record the arrival of shocks at the surface. When the reflectivity of the test surface is low, a covering of thin aluminized Mylar film clearly signals shock arrival times.

Very weak disturbances are observed by schlieren techniques, using either transmitted or reflected light. Multiple slits or grid systems of various configurations can be used to increase the quantity of recorded information. "Light pipes" of glass filaments can be used to transmit light signals from points inaccessible to direct observation to positions of alignment within a single slit, or to other convenient configurations. Other techniques are described, such as velocity-synchronization, shadowgraphing by Scotch-Lite reflection, the use of color film, and time-dependent spectroscopy.

Techniques de caméra maculeuse

T. P. LIDDIARD, JR., et B. E. DRIMMER, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Le Laboratoire d'Artillerie Navale des Etats-Unis, ainsi que d'autres laboratoires, ont perfectionné diverses techniques qui augmentent notablement l'utilité de la caméra maculeuse à miroir tournant. Quand l'auto-luminosité est insuffisante, on emploie plusieurs procédés pour renforcer la lumière, par ex. du ruban adhésif sur les surfaces explosives, des intervalles d'air ou d'argon, une couche de microballons, etc. Quand cela est nécessaire, une lumière extérieure est fournie par des fils explosants, des lampes-éclair explosives, etc. La lumière réfléchie par la surface des matières opaques est utilisée pour enregistrer l'arrivée des chocs à la surface. Quand le pouvoir réfléchissant de la surface d'épreuve est faible, un revêtement mince de film Mylar aluminisé signale clairement les temps d'arrivée des chocs.

On observe de très faibles perturbations par les techniques schlieren, qu'on emploie la lumière transmise ou la lumière réfléchie. On peut utiliser des fentes multiples ou des systèmes à grille de configurations diverses pour augmenter la quantité des observations enregistrées. On peut aussi employer des "tubes lumineux" de filaments en verre pour transmettre des signaux lumineux de points qui sont inaccessibles à l'observation directe à des positions d'alignement à l'intérieur d'une même fente, ou encore à d'autres emplacements appropriés. Les auteurs décrivent d'autres techniques, telles que la synchronisation de vitesse, la sciographie par réflexion de Scotch-Lite, l'emploi de film en couleur et la spectroscopie "fonction du temps."

Methoden für die "Schmier"-Kamera

T. P. LIDDIARD, JR., und B. E. DRIMMER, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Beim Naval Ordnance Laboratory und bei anderen Laboratorien wurden verscheidene Arbeitsmethoden ausgearbeitet, welche die Verwendbarkeit der "Schmier"-Kamera mit rotierendem Spiegel bedeutend erhöhen. Bei ungenügender Eigenluminosität werden verschieden Mittel angewendet um das Licht zu verstärken, wie z.B. Zellophan-Klebestreifen auf Sprengstoff-Oberflächen, Luft- oder Argonspalte, eine Lage von Mikrobläschen usw. Wenn notwendig wird äusseres Licht durch explodierende Drähte, Sprengstoff-Blitzlampen usw. verwendet. Das von der Oberfläche undurchsichtbarer Stoffe reflektierte Licht wird benützt um das Eintreffen der Stosswellen an ihrer Oberfläche zu registrieren. Wenn die Reflexivität der zu untersuchenden Oberfläche gering ist so zeigt ein Überzug mit dünn aluminisiertem Mylarfilm die Ankunftszeit des Stosses deutlich an.

Sehr geringe Störungen werden mit Schlierenmethoden beobachtet, wobei entweder Durchleuchtung oder reflektiertes Licht angewendet wird. Mehrfache Schlitz- order Gittersysteme verschiedener Formen können angewendet werden, um die Menge der aufgenommenen Daten zu vergrösseren. "Lichtleitungen" aus Glasfäden können dazu benützt werden um Lichteindrücke zu übermitteln und zwar von Punkten, die direkter Beobachtung unzugänglich sind zu Stellen die in einer Linie mit einem bestimmten Schlitz oder anderen geeigneten Stellen liegen. Es werden auch noch andere Methoden beschrieben, wie z.B. Geschwindigkeits-Synchronisation, Schattenaufnahmen mit "Scotch-Lite" Reflexstreifen, der Gebrauch von Farbfilm und schliesslich zeitabhängige Spektroskopie.

Some Problems of Mirror Scanning Theory for Inclined Mirrors and Inclined Light Beams

A. S. Dubovik, Institute of Chemical Physics, Academy of Sciences of the USSR, Moscow

(To be presented by title only.)

Problèmes théoretiques de l'enregistrement à miroir en ce qui concerne les miroirs et les rayons inclinés

A. S. Dubovik, Institut de la Physique Chimique, Académie des Sciences de l'URSS, Moscou

Probleme der Spiegelabtastungstheorie in Bezug auf gebogene Spiegel und Strahlen

A. S. Dubovik, Institut der chemischen Physik, Akademie der Wissenschaften der UdSSr, Moskau

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—— THURSDAY 2:00 P.M. SESSION: Cameras — Multiple Shuttered .....

High-Speed Intermittent-See

Robert L. Rodgers, D. B. Milliken Co., Arcadia, Calif.

A new application of an old principle will allow a precision, pin-registration, intermittent camera to record at a rate of 9600 pictures/sec for 40 sec. The short exposure times normally associated with high frame rates can be obtained by the intermittent camera at lower frame rates with many impressive advantages. Consideration is given current intermittent design objectives, resulting in increases in efficiency and present capabilities. Various applications to engineering problems are discussed and illustrated with slides and motion-picture footage.

Un appareil de prise de vues intermittent à grande vitesse

Robert L. Rodgers, D. B. Milliken Co., Arcadia, Californie

Une application nouvelle d'un principe ancien permet maintenant à une caméra intermittente de précision à enregistrement sténopé d'enregistrer à une cadence de 9600 images/s pendant 40 s. Les temps d'exposition courts normalement associés aux cadences rapides d'images peuvent être obtenus avec la caméra intermittente à des cadences d'images plus faibles, ce qui procure de nombreux avantages d'un haut intérêt. L'auteur décrit les objectifs actuels de type intermittent, signale les accroissements de rendement correspondants et indique les possibilités offertes par ces systèmes. Leurs applications diverses aux problèmes de la technique sont examinées et illustrées au moyen de diapositives et de sections de films cinématographiques.

Intermittierende Beobachtung mit Hochgeschwindigkeit

Robert L. Rodgers, D. B. Milliken Co., Arcadia, Kalifornien

Die neue Anwendung eines alten Prinzips wird es einer Präzisionskamera für haargenau aufeinanderpassende intermittierende Aufnahme gestatten, durch 40 Sekunden mit einer Bildgeschwindigkeit von 9.600 Aufnahmen/s zu arbeiten. Die kurzen Belichtungszeiten, die gewöhnlich mit hohen Bildgeschwindigkeiten verbunden sind, können durch die intermittierende Kamera bei niedrigeren Bildgeschwindigkeiten erzielt werden und viele wichtige Vorteile bringen. Es werden jetzige Konstruktionsziele und die sich dadurch ergebenden Steigerungen der Leistungsfähigkeit und der gegenwärtigen Möglichkeiten erörtert. Es werden die verschiedenen Anwendungen für technische Probleme besprochen und durch Diapositive und kinematographische Aufnahmen illustriert.

A Rotating-Mirror Framing Camera With Multiple Focal Plane Shutters

S. J. Jacobs, J. D. McLanahan and P. F. Donovan, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

A camera has been designed with a number of concave mirrors used with a single rotating mirror to create a connected sequence of images which pass several slits that act as focal-plane shutters. The images seen through the slits are relayed to form separate rows of frames in a multiple smear camera arrangement. By combining 30 concave mirrors with 6 properly phased slits a total of 180 frames can be recorded in approximately $\frac{1}{10}$ revolution of a rotating mirror.

The camera now being constructed at the Naval Ordnance Laboratory will use two mirrored faces, 6 by 2 in., of a rectangular rotating mirror. At the anticipated rotor speed of 600 rps approximately 10^6 frames/sec will be attained. Each frame will be about 0.8 in. high and 1.0 in. wide. It will be possible to vary the shutter to framing time ratio from about 0.5 to about 0.05 by varying the width of the slits used in the camera. The effective aperture will remain fixed at about *f*/20. This work was supported in part by the Atomic Energy Commission through the University of California Lawrence Radiation Laboratory, Livermore, California.

Une caméra multi-images à miroir tournant avec obturateurs focaux multiples

S. J. Jacobs, J. D. McLanahan et P. F. Donovan, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

On a réalisé une caméra qui utilise plusieurs miroirs concaves en combinaison avec un miroir tournant unique pour créer une série reliée d'images qui passent devant plusieurs fentes faisant fonction d'obturateurs focaux. Les images vues par les fentes sont transmises de manière à former des rangées séparées d'images dans un système multiple de caméra maculeuse. En combinant 30 miroirs concaves avec 6 fentes correctement phasées, on peut enregistrer un total de 180 images en approximativement $\frac{1}{10}$ème de tour du miroir tournant.

La caméra actuellement en construction au Laboratoire d'Artillerie Navale des Etats-Unis utilisera deux faces réfléchissantes, mesurant 6 pouces sur 2, d'un miroir tournant de forme rectangulaire. A la vitesse prévue de 600 t/s pour l'élément tournant, on atteindra approximativement 10^6 images/s. Chaque image mesurera environ 0,8 pouce de haut et 1,0 pouce de large. Il sera possible de faire varier le rapport du temps d'obturation au temps de prise de vue approximativement de 0,5 à 0,05 en changeant la largeur des fentes utilisées dans la caméra. L'ouverture effective restera fixe à environ *f*/20. Ces travaux ont été patronés en partie par la Commission d'Energie Atomique avec la participation du Laboratoire de Radiation Lawrence de l'Université de Californie, Livermore, Californie.

Eine Bildreihenkamera mit rotierendem Spiegel und Mehrfach-Schlitzverschlüssen

S. J. Jacobs, J. D. McLanahan und P. F. Donovan, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Es wurde eine Kamera entworfen, die eine Anzahl konkaver Spiegel sowie einen einzelnen rotierenden Spiegel hat, um eine verbundene Sequenz von Bildern zu schaffen, die an mehreren Schlitzen (die als Schlitzverschlüsse funeren) vorbeiziehen. Die durch die Schlitze gesehenen Bilder werden übertragen um in einer Mehrfach—"Schmier"—Kamera Anordnung getrennte Reihen von Aufnahmen zu ergeben. Durch eine Kombination von 30 Konkavspiegeln mit 6 entsprechend angeordneten Schlitzen können insgesamt 180 Bilder in ungefähr 1/10 Umdrehung eines rotierenden Spiegels aufgenommen werden.

Die jetzt beim Naval Ordnance Laboratory im Bau befindliche Kamera wird 2 verspiegelte 6 × 2 Zoll Flächen eines rechteckigen rotierenden Spiegels benützen. Bei der erwarteten Geschwindigkeit des Rotors von 600 Umdrehungen/s werden ungefähr 10^6 Bilder je Sekunde erzielt werden. Jedes Bild wird ungefähr 0,8 Zoll hoch und 1,0 Zoll breit sein. Durch Änderung der Breite der verwendeten Spalte wird es möglich sein, das Verhältnis zwischen Verschluss und Aufnahmezeit von rund 0,5 zu rund 0,05 zu ändern. Die wirksame Öffnung wird bei rund 1:20 fixiert bleiben. Diese Arbeit wurde teilweise durch die Atomic Energy Commission durch das University of California Lawrence Radiation Laboratory, Livermore, Kalifornien, ermöglicht.

Focal Plane Shutters and the Design of High-Frame-Rate Cameras

SIGMUND J. JACOBS U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Operating principles for a new family of rotating-mirror framing cameras which make use of focal-plane shutters are described and examples are given. The basic concept is an extension of the idea of isotransport of image and film, presently found only in moving film cameras. The rotating mirror and a number of prisms, plane mirrors, or concave mirrors are used to produce a sequence of connected frames which move past a fixed slit in the camera at constant velocity. The moving image segments seen through the slit are then relayed to a stationary film by means of a smear camera employing the same rotating mirror. The optics of the smear camera is arranged to stop the motion of each image on the film. As a consequence, a series of stationary images which have been scanned by a focal-plane shutter in a known way are formed on the film. Use of the focal-plane shutter offers the possibility of very precise time definition.

Focal-plane shutter characteristics have both advantages and disadvantages in comparison with between-the-lens shutters. One advantage is that multiple slits may be employed. If the images from several equally spaced slits are relayed to independent film areas it is possible to increase the number of frames and the effective framing speed of a camera without increasing rotor speed or sacrificing f-number. Other possible uses of multiple-slit recording are described. This work has been supported in part by the Atomic Energy Commission through the University of California Lawrence Radiation Laboratory, Livermore, California.

Les obturateurs focaux et la construction des caméras à haute cadence d'images

SIBMUND J. JACOBS, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

L'auteur explique, avec de nombreux exemples, les principes de fonctionnement d'une nouvelle série de caméras multi-images à miroir tournant qui utilisent des obturateurs focaux. Le principe de base est une extension de l'idée d'isotransfert de l'image et du film, qu'on ne trouve actuellement que dans les caméras cinématographiques. On utilise un miroir tournant en combinaison avec plusieurs prismes, miroirs plans ou miroirs concaves pour produire une série d'images reliées qui défilent devant une fente fixe de la caméra à une vitesse constante. Les segments d'image mobile vus par la fente sont ensuite transmis à une pellicule fixe au moyen d'une caméra maculeuse qui utilise le même miroir tournant. Le système optique de la caméra maculeuse est disposé de manière à arrêter le mouvement de chaque image sur la pellicule. Il s'ensuit qu'une série d'images fixes qui ont été "explorées" par un obturateur focal d'une manière connue se forme sur la pellicule. L'emploi de l'obturateur focal offre la possibilité d'un réglage très précis du temps.

Les caractéristiques des obturateurs focaux ont à la fois des avantages et des désavantages par rapport aux obturateurs du type entre lentille. Un avantage est qu'on peut employer des fentes multiples. Si les images provenant de plusieurs fentes également espacées sont transmises à des zones indépendantes de pellicule, il est possible d'augmenter le nombre d'images et la cadence effective d'images d'une caméra sans accélérer le miroir tournant et sans sacrifier l'indice-f. L'auteur décrit d'autres emplois possibles de l'enregistrement à fentes multiples. Ces travaux ont été en partie sous l'égide de la Commission d'Energie Atomique avec la participation du Laboratoire de Radiation Lawrence de l'Université de Californie, Livermore, Californie.

Schlitzverschlüsse und der Entwurf von Kameras für hohe Bildgeschwindigkeiten

SIGMUND J. JACOBS, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Es werden die Betriebsgrundsätze und Beispiele angeführt, betreffend eine Gruppe neuer Bildreihenkameras mit rotierenden Spiegeln und Schlitzverschlüssen. Die Grundidee beruht auf dem Isotransport von Bild und Film wie man ihn gegenwärtig nur bei Kameras mit bewegtem Film kennt. Der rotierende Spiegel und eine Anzahl von Prismen, Plan- und Konkavspiegeln werden verwendet, um eine Reihe verbundener Aufnahmen zu erzeugen, die an einem stationären Schlitz in der Kamera mit konstanter Geschwindigkeit vorüberziehen. Die durch den Schlitz geschenen sich bewegenden Bildsegmente werden dann mittels einer "Schmier"-Kamera die den gleichen Rotor-Spiegel hat, auf einer stationären Film übertragen. Die Optik den Schmierkamera ist so angeordnet, dass auf dem Film die Bewegung jedes Bildes gestoppt wird. Der Gebrauch des Schlitzverschlusses (in der Bildebene) gibt die Möglichkeit sehr genauer Zeitdefinition.

Die Charakteristiken des Schlitzverschlusses haben — im Vergleich mit dem Verschluss zwischen den Linsen — sowohl Vor-als auch Nachteile. Ein Vorteil ist der, dass mehrfache Schlitze angewendet werden können. Wenn die Bilder von verschiedenen in gleichen Abständen von einander liegenden Schlitzen auf unabhängige Filmabschnitte übertragen werden, lässt sich die Anzahl der Aufnahmen und die wirksame Bildgeschwindigkeit einer Kamera steigern ohne die Geschwindigkeit des Rotors zu steigern oder die relative Öffnung zu vermindern. Diese Arbeit wurde teilweise durch die Atomic Energy Commission durch das University of California Lawrence Radiation Laboratory in Livermore, Kalifornien ermöglicht.

Kerr Cell Framing Camera

WILLIS C. GOSS, Lawrence Radiation Laboratory, University of California, Livermore, Calif.

Design of a high-speed Kerr cell framing camera is described. A single Kerr cell, pulsed once, is used in conjunction with a system of optical delays to provide six consecutive pictures at interframe times of 1.5×10^{-8} sec and exposure times of 5×10^{-9} sec. The camera is $f/10$ at the 35mm film plane and the pictures have roughly 150×450 information lines content. Source image threshold energy is expected to be at an effective blackbody temperature of $\sim$0.5 ev for Tri-X film. It is expected to find extensive use of the camera in exploding-wire studies as well as high-energy-explosive hydrodynamics.

Une caméra multi-images à cellule Kerr

WILLIS C. GOSS, Lawrence Radiation Laboratory, University of California, Livermore, Californie

L'auteur décrit le type de construction d'une caméra multi-images de grande vitesse à cellule Kerr. On utilise une seule cellule Kerr, à pulsation unique, en combinaison avec un système de retards optiques pour produire six images consécutives à des temps entre images de $1{,}5 \times 10^{-8}$ s et des temps d'exposition de 5×10^{-9} s. La caméra est $f/10$ au plan de film de 35 mm et les images ont approximativement un contenu de 150×450 lignes informatrices. On prévoit que l'énergie de seuil des images à la source sera une température effective de corps noir de $\sim\frac{1}{2}$ ev pour du film Tri-X. On compte que cette caméra trouvera des applications considérables dans les études de fils explosants, ainsi que dans l'hydrodynamique des explosifs extra-puissants.

Bildreihenkamera mit Kerrzelle

WILLIS C. GOSS, Lawrence Radiation Laboratory, University of California, Livermore, Kalifornien

Es wird die Konstruktion einer Hochgeschwindigkeits- Bildreihenkamera mit Kerrzelle beschrieben. Es wird eine einzige Kerrzelle mit Einzelimpuls in Verbindung mit einer Anordnung von optischen Verzögerungen angewendet um sechs aufeinanderfolgende Bilder mit Zwischenbildintervallen von $1{,}5 \times 10^{-8}$ Sekunde und Belichtungszeiten von 5×10^{-9} Sekunde zu erhalten. Die relative Öffnung ist 1:10 auf der 35 mm Filmfläche und die Bilder haben einen Inhalt von ungefähr 150×450 Informationslinien. Die Schwellenenergie der Bildquelle wird voraussichtlich bei einer wirksamen Schwarzkörpertemperatur von $\sim$0.5 ev für Tri-X Film liegen. Man hofft, dass die Kamera weite Verwendung bei Studien mit explodierenden Drähten und in der Hochenergie-Explosions-Hydrodynamik finden wird.

Tripod-Mounted High-Speed Framing Camera

RICHARD J. KRUMHANSL, Lawrence Radiation Laboratory, University of California, Livermore, Calif.

A portable, rotating-mirror framing camera weighing 35 lb has been built. Standard 35mm film cassettes are used. Each 5-ft load is good for 5 exposures and 12 information frames/exposure. All loading and film advance is done in full daylight. The camera has an interframe time of 1 μsec and its variable aperture stops range from $f/10$ to $f/64$. Incorporated within the camera body is a "foolproof" optical synchronizing

Une caméra multi-images à grande vitesse montée sur trépied

RICHARD J. KRUMHANSL, Lawrence Radiation Laboratory, University of California, Livermore, Californie

On a réalisé une caméra multi-images à miroir tournant de type portatif qui pèse 35 lb. Cette caméra utilise des chargeurs de film de 35mm normal. Chaque charge de 5 pieds est bonne pour 5 expositions et pour 12 images informatrices par exposition. Tout le chargement et l'avance du film se font au grand jour. L'appareil est caractérisé par un temps entre images de 1 μs et ses crans d'ouverture variable s'échelonnent de

Auf Dreifuss montierte Hochgeschwindigkeits-Bildreihenkamera

RICHARD J. KRUMHANSL, Lawrence Radiation Laboratory, University of California, Livermore, Kalifornien

Es wurde eine tragbare Bildreihenkamera mit rotierendem Spiegel gebaut, die 35 Pfund wiegt und für normale 35 mm Filmkassetten eingerichtet ist. Jeder eingesetzte Filmstreifen von 5 Fuss Länge genügt für 5 Belichtungen und 12 Bildern je Belichtung. Das Einsetzen und Vorschieben des Films geschieht bei vollem Tageslicht. Die Kamera hat einen Interval von 1 Mikrosekunde zwischen den einzelnen Bildern

"gate." The range of focus is from 5 ft to infinity with typical resolution of 30 timewise by 60 spacewise information lines per millimeter on Panatomic-X film.

Synchronizing electronics are distributed between the camera and a remote portable chassis. Within the camera housing is a transistorized synchronizer preamplifier. Remote electronics include power supply, camera operating chassis, high-voltage pulse and pulse-delay circuits, camera synchronizing circuitry, rotor driving pressure, frequency and lubrication pressure monitors, all with the capability of programed, manual or remote operation. These chassis are mounted in a standard bud rack 24 in. wide and 36 in. tall.

f/10 à *f*/64. Incorporé au corps de la caméra est un "portillon" synchronisateur optique "à l'épreuve des fausses manoeuvres." L'échelle focale va de 5 pieds jusqu'à l'infini avec une résolution typique de 30 lignes informatrices en temps pour 60 lignes informatrices en espace par mm sur film Panatomic X.

Le système électronique synchronisateur est réparti entre la caméra et un châssis portatif à distance. A l'intérieur du boîtier de la caméra est un préamplificateur synchronisateur transistorisé. Le système électronique à distance comprend un appareil alimenteur de courant, un châssis de commande de la caméra, des circuits à pulsation de haut voltage et de retard de pulsation, des circuits synchronisateurs de caméra, ainsi que des contrôleurs de la pression d'entraînent de 'lelement tournant, de la fréquence et de la pression de graissage. Tout ce système se prête au fonctionnement manuel, à programme ou à distance. Les châssis sont montés dans un support à saillies de type standard qui mesure 24 pouces de large et 36 pouces de haut.

und die Blendenöffnung kann von 1:10 bis 1:64 geändert werden. Innerhalb der Kamera ist ein absolut verlässliches optisches Synchronisier-Bildfenster. Die Distanzeinstellung ist von 5 Fuss bis unendlich und die typische Resolution ist 30 zeit- und 60 raummässige Informationslinien je mm auf Panatomic-X Film.

Die elektronische Einrichtung für Synchronisierung ist zwischen Kamera und einem getrennten tragbaren Kasten aufgeteilt. In dem Kameragehäuse ist ein transistorisierter Synchronisier-Vorverstärker. Zu den getrennt untergebrachten elektronischen Teilen gehören: Stromquelle, Kamerabetätigungsmechanismus, Hochspannungsimpuls- und Impulsverzögerungsstromkreise, Regler für Frequenz und Öldruck, Kamera-Synchronisationsstromkreise, Rotorantriebsdruck und alle darauf eingerichtet mit Lochstreifern, von Hand oder fernbetätigt zu werden. Diese Kasten sind auf einem normalen Traggestell, 36 Zoll hoch × 24 Zoll breit, montiert.

—— THURSDAY 3:45 P.M. SESSION: Materials for High-Speed Photography .....

Forced Development of High-Speed 35mm Films

ZEV PRESSMAN, Stanford Research Institute, Menlo Park, Calif.

A series of exposure-development tests was conducted to determine the most effective combination of high-speed film and processing procedure to be used with ultra-high-speed framing and streak cameras for investigations of explosive and shock-wave phenomena. Data obtained from the varied experience of technical personnel and film manufacturers' recommendations influenced the design of a brief-exposure electronic-flash sensitometric device using a calibrated gray step-scale for a standard image. Field tests followed which confirmed our findings.

A variety of "strong" developers were used including stock solutions of paper and x-ray as well as standard commercial film developers. Films were processed at 70 F for normal, normal +50% and twice normal time. Densities were measured on the Welch Densichron, and curves plotted. Rating of films in reference to minimum exposure necessary to raise film density to 0.1 above fog as well as 1.0 above fog was based on ASA and DIN criteria. Royal-X Pan (Kodak) proved to be fastest with Isopan Record (Agfa) next, although it required ½-stop more exposure for equal useful density. However, its infrared fog level was somewhat objectionable. Other films tested, such as Superior 4 (du Pont) and special-purpose films, such as Shellburst, Photoflure and ID2, showed useful characteristics worth considering in special applications.

Le développement forcé des films de 35 mm à grande vitesse

ZEV PRESSMAN, Stanford Research Institute, Menlo Park, Californie

Une série d'essais d'exposition-développement a été entreprise pour déterminer la combinaison la plus efficace de film à grande vitesse et de méthode de traitement à adopter avec les caméras multi-images et à stries de vitesse ultra-grande aux fins d'études des phénomènes relatifs aux explosifs et aux ondes de choc. Les données tirées de l'expérience variée du personnel technique et les recommandations des fabricants de films ont abouti à la réalisation d'un appareil sensitométrique à flash électronique et exposition brève qui utilise une échelle étalonnée à graduations grises comme image normale. Des essais pratiques ont confirmé nos propres observations.

On a employé divers révélateurs "énergiques," entre autres des solutions concentrées pour papier et rayons X, ainsi que des révélateurs commerciaux usuels pour films. On a traité les films à 70 F pour un temps normal, normal + 50% et double de normal. Les densités ont été mesurées sur le Densichron Welch et l'on a tracé les courbes correspondantes. L'évaluation des films pour ce qui est de l'exposition minimum nécessaire pour élever la densité du film à 0,1 au-dessus du voile, ainsi qu'à 1,0 au-dessus du voile, a été basée sur les critères ASA et DIN. Le Royal-X Pan (Kodak) s'est montré le plus rapide, et ensuite l'Isopan Record (Agfa), bien qu'il ait fallu ½ cran de plus d'exposition pour obtenir une densité utile égale. Toutefois, son niveau de voile infrarouge laissait un peu à désirer. Parmi les autres films essayés, le Superior 4 (du Pont) et des films d'emplois spéciaux comme le Shellburst, le Photoflure et l'ID2 ont révélé des caractéristiques pouvant présenter de l'intérêt dans des applications spéciales.

Intensive Entwicklung hochempfindlichen 35 mm Films

ZEV PRESSMAN, Stanford Research Institute, Menlo Park, Kalifornien.

Es wurde eine Reihe von Versuchen zur Feststellung der wirksamsten Kombination von Belichtung und Entwicklung von Hochempfindlichkeitsfilm unternommen, um sie für Höchstgeschwindigkeits-Bildreihen- und Schlierenkameras bei der Untersuchung von Explosions- und Stosswellenerscheinungen zu benützen. Daten, die sich aus den verschiedenen Erfahrungen des technischen Personals und nach den Ratschlägen der Filmfabrikanten ergaben, beeinflussten den Entwurf eines sensitometrischen Apparates mit Elektronenblitz für kurze Belichtungszeiten, bei dem eine Graustufenskala als Normbild dient. Es wurden praktische Versuche unternommen, welche als Bestätigung der gemachten Feststellungen dienten.

Es wurden die verschiedensten "starken" Entwickler verwendet, einschliesslich vorhandener Entwickler für Papier, Röntgenbilder und handelsüblicher Filmentwickler. Die Filme wurden bei 70° F durch normale, halbe normale und doppelte normale Zeit entwickelt. Die Dichten wurden am Welch Densichron gemessen und Kurven festgelegt. Die Einteilung der Filme geschah nach ASA und DIN Kriterien hinsichtlich der minimalen Belichtungszeit die nötig ist um die Filmdichte sowohl auf 0,1 über Schleier als auch auf 1,0 über Schleier zu steigern. Royal-X Pan (Kodak) erwies sich als der schnellste und Isopan Record (Agfa) kam ihm am nächsten, obwohl er eine halbe Blendenstufe mehr Licht für gleich gute Dichte benötigte. Sein infrarotes Schleierniveau ist jedoch etwas unangenehm. Andere Filme, die geprüft wurden, wie Superior 4 (DuPont) und Filme für Spezialzwecke wie Shellburst, Photoflure und ID 2 zeigten praktische Charakteristiken, die für besondere Anwendungen wohl berücksichtigt werden sollten.

High-Speed Direct-Recording Papers

HERMAN D. HUNT, Parlin Research Laboratory, E. I. du Pont de Nemours & Co., Parlin, N. J.

Silver halide emulsions for the direct recording of oscillograph traces represent a new development in the photographic industry. These emulsions will form an immediately visible image at writing speeds up to 10 in./sec when a super-high-pressure mercury arc is used as the light source. With the same source a latent image is formed at writing speeds up to at least 40,000 in./sec. Such latent images can be made visible within a fraction of a second by secondary exposures.

The exposure which forms the image is a very intense radiation of wavelengths absorbed by the silver halide or, it may be, x-rays, gamma-rays or an electron beam, while the amplifying exposure is light-absorbed by the silver halide and is of moderate intensity. Good contrast between image and background and good stability of the background depend on the extreme reciprocity-law failure of these special emulsions, combined with their ability to be desensitized by low-intensity light. The contrast itself depends on the difference in light absorption between the silver of the image and nonimage areas. Properties of these direct-recording papers and mechanisms by which they function are discussed.

Des papiers à enregistrement direct à grande vitesse

HERMAN D. HUNT, Parlin Research Laboratory, E. I. du Pont de Nemours & Co., Parlin, N.J.

Les émulsions à halolde d'argent pour l'enregistrement direct des tracés d'oscillographe constituent une réalisation nouvelle dans l'industrie photographique. Ces émulsions forment une image immédiatement visible à des vitesses d'enregistrement allant jusqu'à 10 pouces/s quand on emploie comme source de lumière un arc au mercure à pression super-élevée. Avec cette même source, une image latente se forme à des vitesses d'enregistrement allant au moins jusqu'à 40.000 pouces/s. Ces images latentes peuvent être rendues visibles en une fraction de seconde par des expositions secondaires.

L'exposition qui forme l'image est une radiation très intense de longueurs d'onde absorbées par l'halolde d'argent ou encore de rayons X, de rayons gamma ou un faisceau d'électrons, alors que l'exposition amplificatrice a sa lumière absorbée par l'halolde d'argent et est d'intensité modérée. Le bon contraste entre l'image et l'arrière-plan et l'excellente stabilité de cet arrière-plan sont dus à ce que ces èmulsions spéciales échappent presque totalement à la loi de réciprocité et sont capables d'être désensibilisées par une lumière de faible intensité. Le contraste proprement dit dépend de la différence d'absorption lumineuse entre l'argent des zones à image et des zones sans image. L'auteur indique les propriétés de ces papiers à enregistrement direct et explique le mécanisme de leur fonctionnement.

Hochempfindlichkeitspapiere für direkte Aufnahmen

HERMAN D. HUNT, Parlin Research Laboratory, E. I. du Pont de Nemours & Co., Parlin, N.J.

Silberhalidemulsionen zur direkten Aufnahme von durch Oszillographen zurückgelassene Bildspuren stellen eine neue Entwicklung in der photographischen Industrie dar. Unter Benützung eines Höchstdruck-Quecksilber-Lichtbogens, der als Lichtquelle dient, bilden diese Emulsionen ein sofort sichtbares Bild bei Aufnahmegeschwindigkeiten bis zu 10 Zoll/s. Es entsteht jedoch mit derselben Lichtquelle bereits ein latentes Bild bie Aufnahmegeschwindigkeiten von bis zu wenigstens 40.000 Zoll/s und diese latenten Bilder können innerhalb von Bruchteilen einer Sekunde durch eine sekun däre Belichtung sichtbar gemacht werden.

Die Belichtung, welche das Bild formt, ist eine sehr intensive Strahlung von Wellenlängen, die das Silberhalid absorbiert, oder es können dies Röntgen–, Gammastrahlen oder Elektronenbündel sein, während die Verstärkungs-belichtung vom Silberhalid lichtabsorbiert wird und von mässiger Intensität ist. Guter Kontrast zwischen Bild und Hintergrund und gute Stabilität des Hintergrunds hängen bei diesen Emulsionen von dem Versagen des äussersten Reziprozitätsgesetzes im Verein mit ihrer Eigenschaft, durch Licht geringer Intensität desensibilisiert zu werden. Der Kontrast selbst hängt von dem Unterschied an Lichtabsorption zwischen dem Silber der Bildgebiete und der Bildlosen ab. Es werden die Eigenschaften dieser Papiere und die Mechanik ihrer Funktion erörtert.

Progress in High-Speed Recording at Atomic Weapons Research Establishment

K. R. COLEMAN and A. SKINNER, Atomic Weapons Research Establishment, Aldermaston, Berks, England

At the Cologne meeting five separate papers were presented describing various aspects of the high-speed photographic work carried out at the British Atomic Weapons Research Establishment. Progress since then is treated from two viewpoints: (1) the extension and utilization of the systems previously described are examined, in particular the use of the cine camera at speeds up to 7×10^6 frames/sec on such events as ϑ-mode discharges and externally illuminated effects of explosions; and (2) attempts to improve present methods of information processing in some types of experiment.

One approach has been to make a minimum of the number of transformations of the physical carriers of the signal, the minimum depending on the physics of the experiment type itself. From this point of view an electronic-optical device is more fundamental with an electric signal output or an electron record such as Lallemand has described. Examples of such devices in this field are given. The major challenge of the future in high-speed recording will be the efficient use of the information obtained. Because the rate of collection of information has increased so much, the methods of the analyzer's mind and the ways in which criteria of choice are satisfied have to be taken into account.

Les progrès de l'enregistrement à grande vitesse à l'Atomic Weapons Research Establishment

K. R. COLEMAN et A. SKINNER, Atomic Weapons Research Establishment, Aldermaston, Berks, Angleterre

Lors de l'Assemblée de Cologne, cinq mémoires distincts ont été présentés qui décrivent les divers aspects des travaux en photographie à grande vitesse qui ont été réalisés par la "British Atomic Weapons Research Establishment." Les progrès accomplis depuis lors sont traités à deux points de vue: (1) l'utilisation et l'extension des systèmes décrits antérieurement, en particulier l'emploi de la ciné-caméra à des vitesses allant jusqu'à 7×10^6 images/s pour l'enregistrement de processus tels que les décharges de mode θ et les effets d'explosions avec éclairement extérieur; et (2) tentatives pour améliorer les méthodes actuelles de traitement d'informations dans certains types d'expériences. Un des buts visés a été d'établir un minimum pour le nombre de transformations des porteurs physiques du signal, ce minimum dépendant des aspects physiques du genre d'expérience lui-méme. A ce point de vue, un dispositif électronique-optique est plus fondamental avec débit de signaux électriques ou enregistrement d'électrons, tel qu'il a été décrit par Lallemand. L'auteur donne des exemples de ce genre d'appareils dans le domaine en cause. Le but principal des recherches de l'avenir en enregistrement à grande vitesse sera l'utilisation efficace des informations recueillies. Etant donné que la quantité totale d'observations relevées a augmenté dans des proportions considérables, il y a lieu de tenir compte des processus mentaux de l'analyseur, ainsi que des méthodes par lesquelles les critères de choix sont satisfaits.

Fortschritte in der Hochgeschwindigkeitsphotographie beim Atomwaffen-Forschungsinstitut

K. R. COLEMAN und A. SKINNER, Atomic Weapons Research Establishment, Aldermaston, Berks, England

Bei der Kölner Tagung wurden fünf verschiedene Papiere vorgelesen, die die verschiedenen Aspekte der Arbeiten darlegen, welche bei dem britischen Atomic Weapons Research Establishment auf dem Gebiet der Hochgeschwindigkeits - Photographie unternommen wurden. Der seit damals gemachte Fortschritt wird von zwei verschiedenen Gesichtspunkten aus betrachtet: 1) Man bespricht die Weiterbildung und Verwendung der früher beschriebenen Systeme, insbesondere die Verwendung der Kine-Kamera bei Geschwindigkeiten bis zu 7×10^6 Aufnahmen/s für Erscheinungen wie ϑ-Modus Entladungen und von aussen beleuchtete Explosions wirkungen; 2) Versuche, die gegenwärtigen Methoden der Datenverarbeitung bei gewissen Arbeiten zu verbessern.

Es wurde ein Schritt dahin unternommen, ein Minimum der Anazhl von Transformationen des physischen Signalträgers zu machen, wobei das Minimum von den physikalischen Eigenschaften der Art von Experimenten abhängt. Von diesem Gesichtspunkt aus ist eine elektronisch-optische Vorrichtung fundamentaler mit einer elektrischen Signalleistung oder einer Elektronenaufzeichnung wie sie Lallemand beschrieben hat. Es werden Beispiele solcher Vorrichtungen in praktischer Verwendung gegeben. Die wichtigste in Zukunft noch zu lösende Frage hinsichtlich der Hochgeschwindigkeitsaufnahmen wird die sein, die erzielten Angaben gut zu verwerten. Es werden jetzt die Angaben um so vieles schneller erzielt, dass man die Methoden im Kopf der analysierenden Person berücksichtigen muss und die Art in der gewählte Kriterien erfüllt werden.

news and reports

Education, Industry News

The BBC Circular Television Center (*Journal*, p. 776, Nov. 1959, and p. 110, Feb. 1958) was officially opened June 29, 1960.

The plan, purpose and construction of the Center as it developed from "a first back-of-envelope idea dated December 1949" have been described in detail by the architect, Graham Dawborn, of the British firm Norman & Dawborn, and M. T. Tudsbery, consulting civil engineer to BBC. A very few excerpts which seem of special interest are taken from the description.

"In a television studio there are two major problems of internal finish: the floor and acoustic treatment of ceiling and walls. The acoustic treatment has been designed to be completely fireproof and to avoid as far as possible the uncovered mineral wools which are an unsightly feature of so many television and film studios. The large studios are of two main types — those for general purposes, including musical shows; and those to be used exclusively for speech and in particular for drama. The general-purpose studios are designed to have a reverberation rather shorter than those of sound studios of similar size; the drama studios are made as non-reverberant as is possible at reasonable cost. It has therefor been necessary to develop several new types of fireproof absorbers. . . .

"Control Rooms for Vision, Lighting and Sound lie behind continuous plate glass windows extending across the inner end of each studio and behind these are the Apparatus Rooms. The production control desk in the vision control room . . . is curved in shape (convex on the sitting side) (affording) a first-class view by key personnel of the studio floor and the picture monitors. . . .

"One operator at the vision control console controls electrically all the cameras in a studio, which may be as many as six. This has been achieved, first by arranging the controls and picture monitors in such a way that the minimum of effort is required by the vision control supervisor and secondly by designing the cameras and their associated control equipment for remote control. The operational controls in the vision control console have been specially developed to enable three functions to be performed with a single control. Moving the control over a quadrant varies the lens aperture, a knob on the control is rotated to adjust the picture black level and pressure on this knob will switch a single monitor from one camera to another.

Studio Three, the first of the seven production studios to be placed in operation, is equipped with 13 Marconi Mark IV image-orthicon camera channels with the English Electric Valve Company's 4½-in. pickup tubes. Other Marconi equipments installed in Studio Three include 11 Mark IV vidicon-camera channels; 75 21-in. monitors; 10 slide projectors; six optical multiplexers; five electronic switches; and three picture and waveform monitors.

Specially designed optical and sound equipment has been suppl[illegible] by Rank Precision Industries, Ltd. The Taylor, Taylor and Hobson Division has provided the optical system for the universal standards converter, developed by the BBC for the "link-up" with the European Broadcasting Union and for video-tape programs for use overseas. This Division has also supplied television camera lenses, including eight studio zooms, three remote control servo zooms and a range of fixed focus lenses. The G.B-Kalee Division has redesigned existing magnetic soundtrack reproducing equipment for telecine operation. Two equipments have been provided. Each comprises a 35mm magnetic soundtrack reproducer for operation with a Cintel flying spot telecine scanner and driven in selsyn interlock. Provision has been made for forward and reverse running under either local or remote control.

The 13th Annual Conference on Electrical Techniques in Medicine and Biology will be held Oct. 31 — Nov. 2 at the Sheraton-Park Hotel, Washington, D.C. Fifty-one papers are scheduled for presentation during eight sessions. Subject matter includes latest developments in analytical methods and instrumentation, electroanalytical methods, digital computers, telemetry of physiological data, physiological measurements, analogs and systems analysis and instrumentation. In addition, four informal discussion sessions will be held on polarography, nuclear and electron magnetic resonance, computer methods, remote recording and stimulating for physiological experiments. Session Chairmen are R. L. Bowman, National Institutes of Health, Bethesda, Md.; R. H. Shepard, Johns Hopkins University; G. N. Webb, John Hopkins University; J. E. Jacobs, Northwestern University; H. B. Schwann, University of Pennsylvania; P. L. Frommer, National Institutes of Health; and W. Greatbatch, University of Buffalo.

All registrants will receive a 100-page letterpress conference report containing digests of the papers supplemented by illustrations. The report will also include a review of the technical and scientific exhibits on display at the Conference. Post-conference copies of the digest will be available at a price of $5.00.

Studio 3's vision control room: the main production desk during installation.

Aerial view of the new BBC Television Centre, Hammersmith, London.

Reasons for Reciprocity Failure at Very Short Exposures

H. Sauvenier, Laboratoire de Physique Générale, Université de Liège, Belgium

A fine-grain AgBr-emulsion, prepared with an inert gelatine, shows no reciprocity failure at very short exposures, if the chemical aging has been effected in the absence of S-unstable ions. In an emulsion with coarse grains (which has therefore undergone the physical aging) there is considerable reciprocity failure. This is due to the fact that the proportion between surface and volume in these emulsions is smaller than in those of a fine grain, so that a gelatine which is inert for the latter is not so any more for an emulsion with coarse grains. If AgI is added to a fine-grain AgBr emulsion which showed no reciprocity failure, there appears a considerable failure at very short exposures.

Sur les causes des écarts de réciprocité aux très courts temps de pose

H. Sauvenier, Laboratoire de Physique Générale, Université de Liège, Belgique

Une emulsion AgBr à grain fin, préparée à l'aide de gélatine inerte, ne présente pas d'écart de réciprocité aux très courts temps de pose pour autant que la maturation chimique ait été effectuée en l'absence d'ions S- labiles. Dans une emulsion à gros grains (qui a donc subi la maturation physique), il apparait un écart de réciprocité aux grands éclairements. Ceci est du au fait que le rapport surface volume de ces émulsions est plus petit que celui des émulsions à grain fin. De sorte qu'une gélatine qui est inerte pour ces dernières ne l'est plus pour une emulsion à gros grains. Si, à une émulsion AgBr à grain fin qui ne présente pas d'écart de réciprocité, on ajoute de l'AgI, il apparait un écart important aux très courts temps de pose.

Die Ursachen der Reziprozitätsabstände bei sehr kurzen Belichtungszeiten

H. Sauvenier, Laboratoire de Physique Générale, Université de Liège, Belgien

Eine feinkörnige AgBr Emulsion, die mit inerter Gelatine hergestellt wurde, zeigt bei sehr kurzen Belichtungszeiten keine Reziprozitätsabstände, wenn das chemische Altern bei Abwesenheit von S-labilen Ionen erfolgte. Bei einer grobkörnigen Emulsion (die also ein physisches Altern mitgemacht hat) sind jedoch bedeutende Abstände vorhanden. Der Grund heifür liegt darin, dass das Verhältnis zwischen Oberfläche und Volumen bei diesen Emulsionen kleiner ist als bei den feinkörnigen, so dass eine Gelatine, die für die letzteren inert ist, sich bei den grobkörnigen nicht mehr so verhält. Wenn man einer feinkörnigen AgBr Emulsion, welche keinen Reziprozitätsabstand aufweist, AgI beisetzt, erscheint ein bedeutender Abstand bei sehr kurzen Belichtungszeiten.

A Photometric Study of Brief Light Sources Associated With Photographic Emulsions

Michel Philbert and Claude Veret, Office National d'Etudes et de Recherches Aéronautiques, Chatillon-sous-Bagneux, France

Lamps with brief discharges are most often employed to photograph rapid phenomena. Now the photometric characteristics of these lamps are as little known as the reactions of the photographic emulsions to brief exposures. The photometric study of discharge lamps associated with photographic emulsions has therefore been undertaken with the view of obtaining practical data for the employment of lamps actually available. One studies, therefore, as a function of time, the overall photographic impression of the rays emitted by the lamp, independent of all consideration of spectral range.

An optical layout with a rotating mirror permits one to obtain, by using a photometric step wedge placed near a slit, photographic records which give directly the curve of the logarithm of the intensity of the light as a function of time. The photometric characteristics of the different sources are compared with one another by taking their ratio to a reference source of steady intensity recorded through the same optical layout, so that one obtains the same duration of exposure. The photographic recordings permit one to define the respective performance of the sources in order to determine the useful working range. Furthermore, they permit one to study the influence of diverse factors such as the electrical parameters on the luminous output of the sources, and this can give very interesting information for the improvement of existing equipment.

Etude photométrique de lumières brèves associées aux émulsions photographiques

Michel Philbert et Claude Veret, Office National d'Etudes et de Recherches Aéronautiques, Chatillon-sous-Bagneux, France

Les lampes à décharges brèves sont le plus souvent employées pour photographier des phénomènes à évolution rapide. Or, les caractéristiques photométriques de ces lampes sont aussi mal connues que les réactions des émulsions photographiques aux lumières brèves. L'étude photométrique des lampes à décharges associées à l'émulsion photographique a donc été entreprise en vue d'obtenir les données pratiques d'emploi des lampes actuellement disponibles. On étudie donc, en fonction du temps, l'impression photographique globale du rayonnement émis par l'éclair, indépendamment de toute considération d'ordre spectral.

Un dispositif optique à miroir tournant permet d'obtenir, grâce à l'utilisation d'un coin photométrique étalonné placé sur une fente, des enregistrements photographiques qui donnent directement la courbe du logarithme de l'intensité de l'éclair en fonction du temps. Les caractéristiques photométriques des différentes sources sont comparées entre elles par rapport à une source de référence continue d'intensité connue, enregistrée au moyen du même dispositif optique pour obtenir la même durée d'exposition. Les enregistrements photographiques réalisés permettent donc de definir les performances respectives des sources pour determiner leurs domaines d'application. Ils permettent, en outre, d'étudier l'influence des divers facteurs, d'ordre électrique ou autre, sur le rendement lumineux des sources, ce qui peut apporter des renseignements tres intéressants pour l'amélioration des équipements existants.

Eine photometrische Untersuchung von Lichtquellen kurzer Dauer in Verbindung mit photographischen Emulsionen

Michel Philbert und Claude Veret, Office National d'Etudes et de Recherches Aéronautiques, Chatillon-sous-Bagneux, Frankreich

Lampen mit kurzdauernden Entladungen werden meistens dazu verwendet Vorgänge zu photographieren, die sich sehr schnell abspielen. Nun sind die photometrischen Charakteristiken dieser Lampen ebenso wenig bekannt wie die Reaktionen der photographischen Emulsionen auf kurze Belichtungen. Die photometrische Untersuchung von Entladungslampen in Verbindung mit photographischen Emulsionen wurde daher zu dem Zweck unternommen praktische Daten für die Anwendung gegenwärtig erhältlicher Lampen zu gewinnen. Man prüft daher, als ein Funktion der Zeit, die von den Strahlen der Lampe verursachte photographische Gesamtbeeinflussung, unabhängig von allen Betrachtungen des Spektrumswertes.

Durch eine optische Anlage mit einem rotierenden Spiegel kann man unter Gebrauch eines photometrischen Stufenkeils, der nahe dem Schlitz angebracht wird, photographische Aufzeichnungen erhalten, welche direkt die Kurve des Logarithmus der Lichtintensität als Funktion der Zeit angeben. Die photometrischen Charakteristiken der verschiedenen Lichtquellen werden mit einander verglichen, indem man ihr Verhältnis zu einer als Bezugselement dienenden Lichtquelle gleichmässiger Intensität, die durch die gleiche optische Einrichtung aufgenommen wurde, feststellt, so dass die gleich Belichtungszeit erzielt wird. Die photographischen Aufzeichnungen ermöglichen eine Bestimmung der Leistung der verschiedenen Lichtquellen so dass man das Gebiet, auf dem sie zweckmässig verwendet werden können, feststellen kann. Sie ermöglichen aber weiterhin auch eine Untersuchung des Einflusses verschiedener Faktoren, wie z.B. der elektrischen Parameter der Lichtleistung dieser Lampen und damit interessante Kenntnisse, die zur Verbesserung bestehender Geräte beitragen können.

——— THURSDAY 6:30 P.M. Cocktail Party

8:00 Banquet, to Honor Foreign Delegates
Entertainment, The Soldiers' Chorus of the U. S. Army Field Band

A study program in motion-picture production has been inaugurated by the University of California Extension. The first two evening courses began Sept. 19 at the Extension Center, 55 Laguna St., San Francisco. A course in "Basic Principles of Motion Picture Production" is taught by C. Cameron Macauley, motion-picture producer for University Extension and member of the faculty of the Film Department, California School of Fine Arts. The course consists of an analysis of the basic principles, tools and skills of production. Demonstrations, film showings and field trips to studios and laboratories are planned to supplement classroom lectures. Any adult may enroll. No previous training is required. "Workshop in Television and Film Scripting" is taught by Carol Levine, film producer and writer. This course deals with scripts for commercials, documentaries, public service and educational programs and films. Courses now being planned will deal with mass media problems, cinematography, television production, experimental films and films as an art form. Further information may be obtained from University Extension, University of California, Berkeley 4, Calif.

Fifteen evening sessions and four Saturday workshop and production classes are offered by the Institute of Film Techniques of City College, New York, for the Fall term. Courses offered include photography, screen writing, sound and film editing, directing and production, with advanced courses open to professionals and elementary classes for amateurs. The Saturday Workshop offers actual experience in all phases of production. Both the evening courses and the Saturday workshop classes are open to persons without previous college training. Registration dates were Sept. 12 through 15 at Shepard Hall, 139 St. at Convent Ave. The announcement was made by Yael Woll, Director of the Institute.

The Audio Engineering Society's 12th Annual Convention and Exhibit will be held Oct. 11–14 at the Hotel New Yorker, New York. Technical sessions scheduled for the four-day meeting will be on the subjects of Psychoacoustical Engineering; Speech Analysis, Synthesis and Compression; Music and Electronics; Disc Recording and Reproducing; Magnetic Tape Recording and Reproducing; Architectural Acoustics and Electronics; Stereophonics; Audio Applications; and Measurements and Standards in Audio.

Papers presented at the Florman & Babb Workshop Seminar, "Animation Film Techniques," held June 12-15 in New York, are being made available in booklet form. The first of the booklets contains a paper on "Creative Problems in Animation Film Commercials" by Peter H. Cooper of Robert Lawrence Animation, Inc. The booklet is available without charge upon request to Charles Lipow, Florman & Babb, Inc., 68 W. 45 St., New York 36.

OCTOBER 21 — FRIDAY 9:00 A.M. SESSION: Applications — Ballistics

New Technique for Measurement of Velocity of High-Speed Objects

DONALD A. HALL and W. W. ATKINS, U.S. Naval Research Laboratory, Washington, D. C.

A new technique for the velocity measurement of controlled trajectory particles, projectiles, models or other masses has been developed for laboratory use in the study of ballistic phenomena. One principal advantage of this system is that the velocity of individual objects throughout a wide velocity spectrum can be measured for any given firing of the accelerator.

The system employs a standard Fastax streak camera as a film transport. Collimated light fields are placed along the trajectory through which the projectile or particle will pass. A narrow vertical slit, near and perpendicular to the trajectory, provides a submicrosecond shutter when image demagnification × rate of film travel equals or approaches the object velocity. A series of mirrors rotates the slit image 90°, enabling the light field to produce a ribbonlike exposure along the entire length of film. A projectile entering the light field creates an instantaneous shadow at the slit and is recorded as such on the film. This is repeated at two or more carefully spaced stations along the trajectory. With the projectile images and time-base markers produced simultaneously, it is necessary only to measure image displacement and determine rate of film travel to calculate object velocity.

Une nouvelle technique pour mesurer la vitesse des objets en parcours rapide

DONALD A. HALL et W. W. ATKINS, U.S. Naval Research Laboratory, Washington, D. C.

Une nouvelle technique pour la mesure des vitesses des particules, projectiles, modèles ou autres masses sur trajectoire contrôlée a été mise au point en vue de son emploi au laboratoire dans l'étude des phénomènes balistiques. Un des principaux avantages de ce système réside dans le fait que la vitesse d'objets isolés dans toute l'étendue d'un ample spectre de vitesse peut être mesurée pour toute position donné de lancement de l'accélérateur.

Le système utilise une caméra à stries Fastax de type normal comme porte-film. Des champs lumineux collimatés sont disposés le long de la trajectoire que le projectile ou la particule doit suivre. Une fente verticale et étroite, près de la trajectoire et perpendiculaire à celle-ci, fait fonction d'obturateur à submicrosecondes quand le produit de la multiplication de la désamplification de l'image par la vitesse de déplacement du film égale ou approche la vitesse de l'objet. Une série de miroirs fait tourner l'image de fente de 90°, ce qui permet au champ lumineux de produire une exposition en forme de ruban sur toute la longueur du film. Un projectile, à son entrée dans le champ lumineux, crée une ombre instantanée à la fente et est enregistré sous cette forme sur le film. Ceci se répète à deux ou plusieurs emplacements judicieusement espacés le long de la trajectoire. Vu que les images de projectile et les jalons à base de temps sont produits simultanément, il suffit simplement de mesurer le déplacement de l'image et de déterminer la vitesse de déplacement du film pour pouvoir calculer la vitesse de l'objet.

Eine neue Methode der Geschwindigkeitsmessung von Hochgeschwindigkeitsobjekten.

DONALD A. HALL und W. W. ATKINS, U.S. Naval Research Laboratory, Washington, D.C.

Zum laboratoriumsmässigen Gebrauch bei der Untersuchung ballistischer Erscheinungen wurde eine neue Methode der Geschwindigkeitsmessung von Partikeln, Projektilen, Modellen und anderen Massen mit geregelter Flugbahn geschaffen. Ein Hauptvorteil dieses Systems ist der, dass die Geschwindigkeit einzelner Objekte bei jedem einzelnen Abfeuern des Beschleunigers durch ein breites Geschwindigkeitsspektrum gemessen werden kann.

Das System benützt eine normale Fastax Schlierenkamera als Filmtransport. Entlang der vom Projektil oder Partikel zu durchlaufenden Strecke werden kollimierte Lichtfelder angeordnet. Ein enger vertikaler Schlitz, nahe der Flugbahn und senkrecht zu ihr, bildet einen Verschluss für weniger als eine Mikrosekunde, wenn Bildverkleinerung mal Filmfortbewegung gleich oder nahe der Geschwindigkeit des Objekts sind. Eine Reihe von Spiegeln, die das Schlitzbild um 90° verdreht, gestattet es dem Lichtfeld, entlang der ganzen Filmlänge eine bandförmige Belichtung zu produzieren. Ein in das Lichtfeld eindringendes Projektil wirft sofort einen Schatten auf den Schlitz und wird als solcher am Film aufgenommen. Dies wiederholt sich bei zwei oder mehreren sorgfältig angeordneten Stationen entlang der Flugbahn. Da die Bilder des Projektils und die Merkpunkte für die Zeitgrundlage gleichzeitig produziert werden, ist es nur nötig, die Bildverlagerung zu messen und die Geschwindigkeit der Filmbewegung zu bestimmen um die Objektgeschwindigkeit errechnen zu können.

Study of Chemical Reactions in Gases Emerging From Muzzle of a Gun by Means of High-Speed Photography

KARTAR SINGH, Institute of Armament Studies, Poona, India

The intensity of reactions of approximately 100 msec duration at various points in a jet stream depends upon temperature and concentration of oxygen prevailing in these regions. High-Speed photography is a powerful tool for study of these chemical reactions. The present note describes investigations on flash from W and NH propellants, at camera speeds of 1500 and 3000 frames/sec.

Etude des réactions chimiques des gaz à leur sortie de la bouche des armes à feu au moyen de la photographie à grande vitesse

KARTAR SINGH, Institute of Armament Studies, Poona, Inde

L'intensité de réactions d'une durée d'environ 100 ms en divers points d'un jet gazeux est fonction de la température et de la concentration d'oxygène qui règnent dans ces zones. La photographie à grande vitesse est un moyen de grande efficacité pour étudier ces réactions chimiques Le présent article décrit les investigations qui ont été faites sur le flash émanant d'agents propulseurs W et NH à des cadences de caméra de 1500 et de 3000 images/s.

Untersuchung der chemischen Reaktionen in von der Rohrmündung eines Geschützes austretenden Gasen mittels Hochgeschwindigkeits-Photographie

KARTAR SINGH, Institute of Armament Studies, Poona, Indien

Die Intensität von Reaktionen, die eine Dauer von ungefähr 100 Mikrosekunden haben, an verschiedenen Punkten eines Gasstrahls hängt von der Temperatur und der Konzentration des Sauerstoffs in diesen Zonen ab. Die Hochgeschwindigkeits-Photographie ist bei der Untersuchung dieser Reaktionen von grosser Wichtigkeit. Der gegenwartige Artikel beschreibt Untersuchungen des Mündungsfeuers von W und NH Treibladungen bei Bildfrequenzen von 1500 und 3.000 Aufnahmen/s.

Microsecond Observations of the Dynamic Response of Explosives to Very High Rates of Loading

H. S. NAPADENSKY and J. SAVITT, Armour Research Foundation of Illinois Institute of Technology; and R. H. STRESAU, Consultant, Lake Zurich, Ill.

An explosive sensitivity test has been devised wherein specimens of explosives of the order of a pound in weight are squeezed between an explosive-driven plate and a massive anvil. By using the Beckman & Whitley Model 189 Framing Camera, it is possible to observe the movement of the driving plate, the propagation of the nonreactive shock in the explosive sample, the deformation of the explosive as a result of its being squeezed, and in some cases the onset

Les observations à microsecondes de la réaction dynamique des explosifs aux régimes de charge très élevés

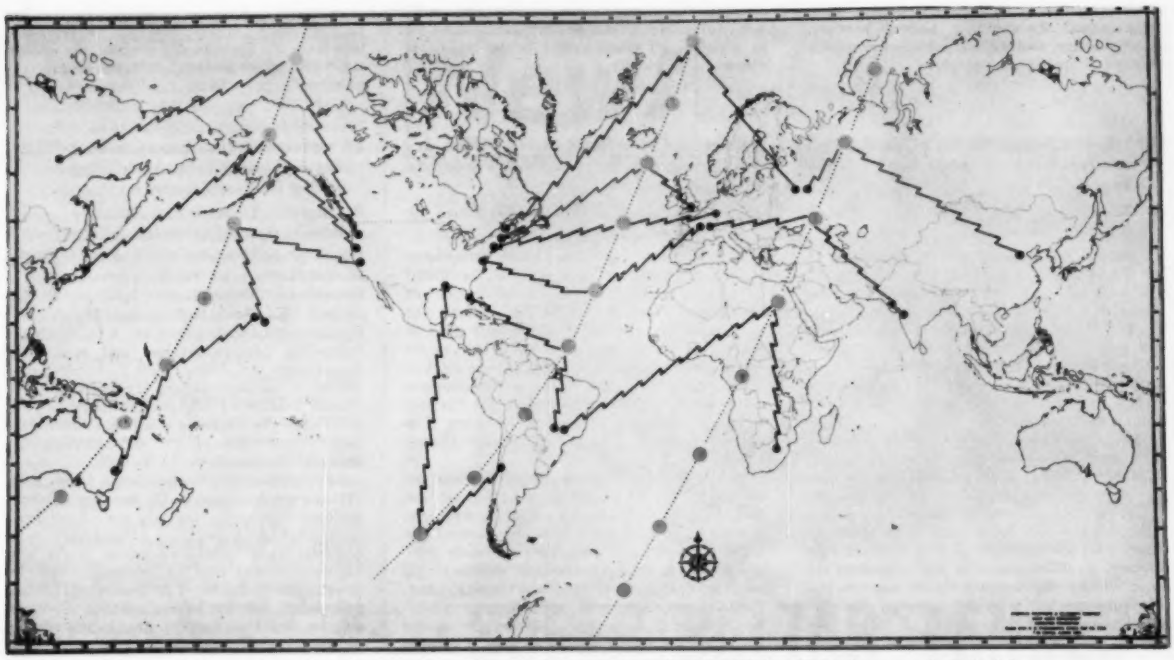
H. S. NAPADENSKY et J. SAVITT, Armour Research Foundation of Illinois Institute of Technology, et R. H. Stresau, expert-conseil, Lake Zurich, Illinois

On a mis au point un essai de sensibilité d'explosifs qui consiste à comprimer des spécimens d'explosif d'un poids de l'ordre d'une livre entre une plaque actionnée par explosif et une enclume massive. En employant la caméra multi-images Beckman & Whitley Modèle 189, il est possible d'observer le déplacement de la plaque d'entraînement, la propagation du choc non réactif dans le spécimen d'explosif, la déformation de l'explosif sous l'effet de la compression, et dans certains cas le début et la propagation d'une réaction explosive. On peut facilement calculer, à

Mikrosekundenbeobachtungen der dynamischen Reaktion von Sprengstoffen bei sehr starken Ladungen

H. S. NAPADENSKY und J. SAVITT, Armour Research Foundation of Illinois Institute of Technology; und R. H. Stresau, Beratender Ingenieur, Lake Zurich, Ill.

Es wurde eine Prüfung der Empfindlichkeit von Sprengstoffen erdacht, in der Proben des Sprengstoffs im Gewicht von einem Pfund zwischen einer durch Sprengstoff vorgetriebenen Platte und einem massiven Amboss zusammengedrückt werden. Unter Benützung einer Beckman and Whitley Bildreihenkamera Modell 189 ist es möglich, die Bewegung der Stossplatte, die Fortpflanzung des nichtreaktiven Stosses im Sprengstoffmuster, die Verformung des Sprengstoffs durch das Zusammendrücken und manchmal auch den Beginn und die Fortpfanzung



Preliminary Plan of Transmitter-Receiver Stations Located Throughout the World for Telephone and Television Communication.

Education, Industry News — Continued

A world-wide satellite communication network has been proposed by Bell Telephone laboratories. Preliminary plans are now being formulated which may culminate in the establishment of transoceanic telephone and television transmission facilities. These and other plans for satellite communication systems have become more significant as a result of Project Echo and the historic telephone calls on August 15 from the Jet Propulsion Laboratory in Goldstone, Calif., to Bell Telephone Laboratories in Holmdale and from Holmdale to Goldstone. To transmit the message from California (a taped message by President Eisenhower) JPL scientists beamed microwave signals at a 100-ft diameter sphere which had been placed into orbit earlier from Cape Canaveral. The aluminum-coated sphere, 1000 miles above the Earth, reflected the signals and they were received at Bell Laboratories by a "horn-reflector" antenna system designed especially for the space communication experiments.

Present experiments are aimed at determining the technical feasibility of commercial overseas communications by way of reflecting, or "passive" satellites. Scientists at Bell Laboratories have also been investigating the possibility of "active" satellites which would carry electronic equipment to receive radio signals and send them back to Earth. A plan for a communication network based on active satellites has been presented to the FCC by the Bell Telephone System. Under this plan about 50 active satellites in random polar orbits at an altitude of 3000 miles would be used to provide communication facilities between the United States and all other areas of the world.

Interlingua, a "made" language used to facilitate international communication, particularly among scientists and technicians, was used at the recently held First International Congress of Endocrinology for programs and all advance abstracts. The vocabulary of Interlingua is based on words internationally known — Greek, Latin and Romance languages predominate — which have been given standardized forms and definitions; and on a greatly simplified grammar. Interlingua is not intended to supplant, but rather to supplement, native tongues, according to an article published in the August 1952 *Journal*, "International Auxiliary Language for Motion Pictures" (pp. 107–108). Alfred N. Goldsmith, a Past-President of the SMPTE, has served on the Board of Directors of the International Auxiliary Language Association since it was founded.

and propagation of an explosive reaction. Conditions within the explosive, such as pressure, density change, and particle velocity are readily computed from the photographs.

High-Speed Measurement of Shock Compressibility of Solids in the 1-Mb Range

R. Schall, Institut Franco-Allemand de Recherches, St,-Louis, France

By impact of flat high-velocity projectiles or fast shaped charge jets, shocks of higher strength may be produced in solid targets than by direct attack of high explosives. Impact pressures in the 1-Mb range are reported for metals, water and geological formations. Three experimental methods are applied to measure shock compressibility: (1) projectile impact (USSR); (2) free surface (Los Alamos Lab.); and (3) flash radiographic (St. Louis Lab.).

Results from experiments obtained following these techniques show that the shock velocity U_s for nearly all tested materials can be presented by a linear relation $U_s = U_0 + \lambda U_p$ within a particle velocity range $U_p = 1$–5 mm/μs, where $\lambda \sim 1.6$ is found to be about the same, even for materials of very different consistency. U_s differs generally noticeably from the sonic velocity. For compact metals, experimental U_0-values accord with a universal function of the argument $(Z-10/\rho)$, Z being the atomic number and ρ the density of the metal.

Détermination de la compressibilité des solides soumis à des chocs de l'ordre de 1Mbar

R. Schall, Institut Franco-Allemand de Recherches, St.-Louis, France

Lors de l'impact de projectiles plats extrêmement rapides ou de jets de charges creuses, on obtient dans les solides des pressions plus élevées que par effet direct d'explosifs même très brisants. On dispose de mesures de compressibilité dans la gamme de 1 Mbar pour des métaux, l'eau et des formations géologiques. Actuellement on emploie 3 méthodes expérimentales pour la détermination de la compressibilité dans les chocs: (1) l'impact balistique (URSS); (2) la surface libre (Los Alamos Lab); (3) radiographie-éclair (Saint-Louis).

Il découle des résultats acquis d'après ces méthodes, que la vitesse du choc U_s est une fonction linéaire $U_s = U_o + \lambda U_p$ dans une gamme $U_p = 1$...5 km/s de la vitesse materielle U_p et que $\lambda \sim 1,6$ ne varie que peu, même pour des matériaux de consistance très différente. U_o est en général assez différent de la vitesse sonique. Pour les métaux compacts, les valeurs expérimentales de U_o se groupent étroitement autour d'une fonction de paramètre $(Z\text{-}10)/\rho$, Z étant le nombre atomique.

Kompressibilitätsmessungen im 1-Mbar-Bereich an intensiven Stosswellen in Festkörpern

R. Schall, Deutsch-Französisches Forschungsinstitut, St.-Louis, Frankreich

Durch Beschuss mit flachen Hochgeschwindigkeitsgeschossen oder Hohlladungen werden in Festkörpern höhere Drücke erreicht als bei direkter Einwirkung hochbrisanter Sprengstoffe. Kompressibilitätsmessungen im 1 Mbar-Gebiet liegen für Metalle, Wasser und geologische Formationen vor. Derzeit sind 3 experimentelle Methoden zur Bestimmung der Verdichtung in Stossen bekannt: (1)die Beschussmethode (Ud-SSR); (2) die Methode der freien Oberfläche (Los Alamos Lab.); (3) die Röntgenblitzmethode (St.-Louis).

Experimentell ergibt sich aus diesen, dass die Stossgeschwindigkeit U_s von der Materiegeschwindigkeit U_p für $U_p = 1.5$ km/s linear abhängt: $U_s = U_0 + \lambda U_p$, wobei $\lambda \sim 1,6$ angenähert für alle kondensierte Stoffe gilt. U_0 unterscheidet sich u.a. wesentlich von der Schallgeschwindigkeit. Für kompakte Metalle gruppieren sich die experimentellen U_0-Werte eng um eine Funktion des Argumentes $(Z\text{-}10)/\rho$, wobei Z die Ordnungszahl bedeutet.

A Photographic Technique for Observing the Behavior of Porous Materials When Rapidly Compressed

H. S. Napadensky and J. Savitt, Armour Research Foundation of Illinois Institute of Technology; and R. H. Stresau, Consultant, Lake Zurich, Ill.

An experimental technique has been developed at Armour Research Foundation to determine, by means of photographic observation, the dynamic response of porous materials to very high rates of loading. In this experimental procedure, a metal plate is propelled by means of a controlled detonation of a thin layer of low-density high explosive in a manner to compress uniformly a specimen of the test material.

A streak camera is used to record the motion of the metal plate and of the lines of a reference grid which is stencilled on the specimen. From the photographic records, one can directly observe the motion of the plate, the distortion of the specimen and the wave propagation in the specimen. Calculations are then easily made of the magnitude and attenuation of pressure pulses propagating in the specimen, the coefficient of restitution, and the stress-strain relationships for various rates of strain. The physical properties of a variety of porous media have been investigated by this technique.

Une technique photographique pour l'observation du comportement des matières poreuses sous compression rapide

H. S. Napadensky et J. Savitt, Armour Research Foundation of Illinois Institute of Technology, et R. H. Stresau, expert-conseil, Lake Zurich, Ill.

Une technique expérimentale a été mise au point à la Fondation de Recherches Armour en vue de déterminer, au moyen de l'observation photographique, la réaction dynamique des matières poreuses aux régimes de chargement très élevés. Selon cette technique d'expérimentation, une plaque métallique est propulsée au moyen de la détonation contrôlée d'une couche mince d'un explosif puissant à faible densité de manière à comprimer uniformément un spécimen de la matière à essayer.

On utilise une caméra à stries pour enregistrer le mouvement de la plaque métallique et des lignes d'un treillis à repères qui est peint au pochoir sur le spécimen. Par un examen des enregistrements photographiques obtenus, on peut observer directement le déplacement de la plaque, la déformation du spécimen et la propagation des ondes au sein du spécimen. Il est alors facile de calculer d'après ces données la grandeur et l'atténuation des impulsions de pression qui se propagent dans le spécimen, le coefficient de restitution et les rapports entre efforts et tensions pour divers régimes de déformation. On a étudié au moyen de cette technique les propriétés physiques de divers agents poreux.

Eine photographische Methode zur Beobachtung des Verhaltens poröser Stoffe bei plötzlicher Kompression

H. S. Napadensky und J. Savitt, Armour Research Foundation of Illinois Institute of Technology und R. H. Stresau, Beratender Ingenieur, Lake Zurich, Ill.

Es wurde bei der Armour Research Foundation eine Versuchsmethode ausgearbeitet, um die dynamische Reaktion poröser Stoffe auf starke Kompression durch photographische Beobachtung zu bestimmen. Bei diesem experimentellen Vorgang wird eine Metallplatte durch die geregelte Detonation einer dünnen Schicht von Sprengstoff geringer Dichte in einer solchen Weise vorgetrieben, dass sie eine Probe des zu prüfenden Stoffes gleichmässig zusammendrückt.

Zur Aufnahme der Bewegung der Metallplatte und der Linien eines Referenzgitters das auf die Probe aufschabloniert wird, verwendet man eine Schlierenkamera. Nach den photographischen Aufnahmen lässt sich die Bewegung der Platte, die Verformung der Probe und die Wellenfortplanzung in derselben direkt beobachten. Es lassen sich dann leicht verschiedene Erscheinungen errechnen: Grösse und Nachlassen der Druckimpulse in der Probe, Wiederherstellungskoeffizient und Spannungs-Beanspruchungsverhältnisse für verschiedene Belastungen. Es wurden mit dieser Methode die physikalischen Eigenschaften verschiedentlichster poröser Stoffe untersucht.

Application of the "Slit-Aperture" Camera for Observation and Data Acquisition

Stanley M. Keen, Instrumentation Laboratory, Development and Proof Services, Aberdeen Proving Ground, Md.

The "Slit-Aperture" camera was first constructed by making two modifidations to a standard Fastax high-speed camera. The first modification was to remove the rotating prism which served as the shutter and secondly to insert a mask having

L'application de la caméra à "ouverture-fente" aux fins d'observation et d'obtention de renseignements

Stanley M. Keen, Instrumentation Laboratory, Development and Proof Services, Aberdeen Proving Ground, Maryland

La caméra à "ouverture-fente" a été initialement construite en apportant deux modifications à une caméra à grande vitesse Fastax de type normal. La première de ces modifications a consisté à enlever le prisme tournant qui servait d'ob-

Verwendung der "Schlitzöffnungs"-Kamera für Zwecke der Beobachtung und der Sammlung von Daten

Stanley M. Keen, Instrumentation Laboratory, Development and Proof Services, Aberdeen Proving Ground, Md.

Die "Schlitzöffnungs"—Kamera wurde zuerst so gebaut, dass man an einer normalen Fastax Hochgeschwindigkeits-Kamera zwei Abänderungen vornahm. Die erste bestand darin, das rotierende Prisma abzunehmen, welches als Verschluss diente, und die zweite, indem man

The Institute for Education by Radio – Television was held in May at The Ohio State University. At this, the 24th, American Exhibition of Educational Radio and TV Programs, awards were made to the following programs (I indicates National; II, Regional and Local):

Programs for Special Interest Groups; agricultural, religious, women's, etc. — (I) *Candid Eye*, National Film Board of Canada and the Canadian Broadcasting Corp.; *Upjohn Grand Rounds*, Medical Radio and Television Inst., New York; (II) *Electricity At Work*, Dept. of Agricultural Engineering and Station WSMB, Michigan State Univ.

Cultural Programs; drama, art, science, literature, etc. — (I) *Leonard Bernstein and the New York Philharmonic*, Robert Saudek Assoc. and CBS; *CBS Folio*, Canadian Broadcasting Corp.; (II) *Laughter's A Funny Business*, Station WGBH-TV, Boston; *Science In Action*, California Academy of Science and Station KRON-TV, San Francisco

Programs Dealing with Personal and Social Problems — (I) *The Lost Class of '59*, CBS News; *Hoffa and the Teamsters*, CBS News; (II) *Tabloid*, Regional Network, Canadian Broadcasting Corp; *Man 1959; An Appraisal*, Station KPIX, San Francisco

Public Affairs Programs: Documentaries, panels, news interpretations, etc. — (I) *CBS Reports*, CBS News; *Twentieth Century Revolutions*, Univ. of Denver Social Science Foundation, Station KRMA-TV, Denver, and the National Educational Television and Radio Center; (II) *Seattle Reports*, KING Broadcasting Co., Seattle, Wash.; *Project: New York*, Station WRCA-TV, New York

Special One-Time Broadcasts — (I) *Where Will They Go?*, Canadian Broadcasting Corp.; *The Splendid American* News and Public Affairs, American Broadcasting Co.; (II) *Harlem — A Self Portrait*, Station WCBS-TV, New York; *A "Sound" Life*, Station WSB-TV, Atlanta.

Systematic Instruction for Adult and College Levels — (I) *Continental Classroom — Modern Chemistry*, National Broadcasting Co.; *Logic of Life*, Canadian Broadcasting Corp.; (II) *Live and Learn – French*, Canadian Broadcasting Corp.; *Man the Maker*, Univ. of Michigan Television

Programs for Children and Youth (Out-of-School Viewing) — (I) *New York Philharmonic Young People's Concerts*, Columbia Broadcasting System; *Friendly Giant*, Canadian Broadcasting Corp.; (II) *American Musical Theatre*, Station WCBS-TV, New York; *Fun At One*, New York State Regents Project, New York City Board of Education and the Baldwin Public Schools

School Telecasts (for Use in School Classrooms) — (II) *Biology, Grade 9*, Cincinnati Public Schools and Station WCET, Cincinnati; *Elementary Science*, Station WQED, Pittsburgh; *Exploring Nature*, National Science Television Project and Station WGBH-TV, Boston

A Special Citation was given to *Hell Flower*, Station KNXT, Los Angeles.

a narrow aperture or slit in front of the film plane. The slit was oriented so that the long dimension extended across the width of the film and the narrow dimension or width of the slit was in the line of film travel.

This camera has been utilized to secure: (1) large-size qualitative photographs of high-velocity projectiles; (2) angular attitude of projectiles in flight; (3) velocity data of projectiles having a minimum length of 2 ft using one camera; (4) rate of spin or the rotation about the longitudinal axis of a projectile; (5) deceleration of the base of a projectile during "crush-up" of the fuze after impacting a non-yielding target; and (6) acceleration of a projectile during the early phase of firing.

turateur et la deuxième à intercaler un masque ayant une ouverture ou fente étroite à l'avant du plan du film. Cette fente a été orientée de telle manière que son côté long soit dirigé transversalement par rapport à la largeur du film et que son côté court soit parallèle au sens de déplacement du film.

On a utilisé cette caméra pour obtenir: (1) des photographies qualitatives de grand format des projectiles à grande vitesse; (2) la hauteur angulaire des projectiles en cours de vol; (3) des données de vitesse pour des projectiles ayant une longueur minimum de 2 pieds en employant un seul appareil de prise de vues, (4) la vitesse de pivotement ou rotation autour de l'axe longitudinal d'un projectile; (5) la décélération de la base d'un projectile pendant "l'écrasement" de la fuse après l'impact contre un objectif rigide; et (6) l'accélération d'un projectile au cours de la phase initiale du tir.

eine Maske mit einer schmalen Öffnung oder Schlitz vor der Filmfläche anbrachte. Die Richtung des Schlitzes war so, dass seine Länge sich über die Breite des Films erstreckte und die Schmaldimension oder Breite des Schlitzes in der Richtung des Filmtransports war.

Die Kamera wurde dazu benützt folgende Aufgaben zu erfüllen: 1) Qualitative Aufnahmen in grossem Format von Hochgeschwindigkeits-Projektilen; 2) Winkellage der fliegenden Geschosse; 3) Geschwindigkeitsdaten über Geschosse einer Minimallänge von 2 Fuss unter Benützung einer Kamera; 4) Rotationsgeschwindigkeit eines Geschosses um seine Längsachse; 5) Verlangsamung des Geschossbodens während des Zerdrückens des Zünders nach dem Aufschlag auf ein unnachgiebiges Ziel; und 6) Beschleunigung eines Geschosses während der Anfangsphase des Abfeuerns.

FRIDAY 10:45 A.M. SESSION: Applications — Miscellaneous in Industry .....

The Micro-Photography of Dilute Fiber Suspensions Moving at High Speed

E. L. Scott, The Mead Corp., Chillicothe, Ohio

The development and commercial availability of high-intensity, short-duration lights, such as the Strobolume, and the extremely fast action magnetooptic Rapatronic shutter (0.5 μsec effective exposure time) has made possible the development of a te hnique for the stop-motion photography of flowing cellulose fiber suspension in water moving at speed of 25 to 30 ft/sec.

In order to provide a uniformly illuminated field this technique utilizes a Fresnel field lens between the light source and the suspension and an auxilary lens between the Rapatronic shutter and suspension to provide the desired magnification of 1.5 : 1 on a 4 × 5 negative. Kodak Royal Pan film was found to be well adapted for this type of work so that normal photographic procedures provided negatives of high quality.

La microphotographie des suspensions diluées defibres en déplacement rapide

E. L. Scott, The Mead Corp., Chillicothe, Ohio

La réalisation et la disponibilité commerciale des lampes à courte durée et haute intensité, telles que la Strobolume, et l'emploi de l'obturateur Rapatronic magnéto-optique à action ultra-rapide (temps d'exposition effectif de 0,5 μs) ont permis la mise au point d'une technique pour la photographie à "arrêt de mouvement" de suspensions aqueuses mobiles de fibres de cellulose se déplaçant à une vitesse de 25 à 30 pieds/s. Afin d'obtenir un champ uniformément éclairé, cette technique utilise un objectif de champ Fresnel entre la source de lumière et la suspension et un objectif auxiliaire entre l'obturateur Rapatronic et la suspension pour réaliser l'amplification désirée de 1,5 : 1 sur un négatif de 4 × 5. Le film "Kodak Royal Pan" s'est montré très approprié pour ce genre de travail, car il a donné des négatifs de haute qualité par les procédés habituels de photographie.

Die Mikrophotographie von sehr ra sc fliessenden dünnen Fasersuspensionen

E. L. Scott, The Mead Corp., Chillicothe, Ohio

Es wurden jetzt Lichtquellen hoher Intensität und kurzer Dauer wie das Strobolume entwickelt und handelsmässig erhältlich gemacht sowie der ausserordentlich rasch arbeitende magnet-optische Rapatronic-Verschluss von 0,5 Mikrosekunden wirksamer Belichtungszeit; dies ermöglichte die Ausarbeitung einer Methode zur Bewegungsausschaltenden Photographie einer Suspension von Zellulosefasern in Wasser, die sich mit einer Geschwindigkeit von 25 bis 30 Fuss/s bewegt.

Um ein gleichmässig beleuchtetes Feld zu schaffen, verwendet diese Methode eine Fresnel Feldlinse zwischen der Lichtquelle und der Suspension und eine Hilfslinse zwischen Rapatronic-Verschluss und Suspension, um die gewünschte Vergrösserung von 1,5 : 1 auf einem 4 × 5 Negativ zu erzielen. Für diese Art von Arbeiten erwies sich Kodak Royal Pan Film als sehr geeignet, da normale photographische Behandlung ausgezeichnete Negative lieferte.

High-Speed Photography in the Development of a New Form of Pulverizer

R. Jackson and D. V. Simpson, British Coal Utilisation Research Assn., Leatherhead, Surrey, England

Normal methods of exploration of the performance of a new pulverizer gave anomalous results that were not easy of explanation. High-speed photographs of the flow of particles through the pulverizer revealed directly many of the causes of these anomalies. A new design of the mill based on these findings has been made and high-speed photography is being used as a tool in the investigation of its performance. The high-speed photography technique is straightforward using a Fastax camera, at speeds up to 1000 frames/sec, the major problems having been inaccessibility of subject and provision of sufficient light, since the material being pulverized was coal.

L'emploi de la photographie à grande vitesse dans la réalisation d'une nouvelle forme de broyeur

R. Jackson et D. V. Simpson, British Coal Utilization Research Assn., Leatherhead, Surrey, Angleterre

Les méthodes habituelles d'investigation du fonctionnement d'un nouveau broyeur avaient donné des résultats présentant des anomalies difficilement explicables. La prise de photographies à grande vitesse de la marche des particules dans le broyeur a révélé directement un grand nombre des causes de ces anomalies. Un nouveau type de broyeur a été réalisé sur la base de ces observations et l'on a utilisé la photographie à grande vitesse pour en étudier le fonctionnement. La technique de photographie à grande vitesse mise en oeuvre est la méthode directe avec une caméra Fastax prenant des vues à des vitesses allant jusqu'à 1000 images/s; les principaux problèmes qu'on a résolus étaient l'inaccessibilité du sujet à photographier et la nécessité d'une lumière suffisante, car la matière à broyer était du charbon.

Hochgeschwindigkeitsphotographie zur Entwicklung einer neuartigen Pulverisiermaschine

R. Jackson und D. V. Simpson, British Coal Utilization Research Assn., Leatherhead, Surrey, England

Normale Methoden zur Untersuchung der Leistung einer neuen Pulverisiermaschine gaben anomale Ergebnisse, die nicht leicht zu erklären waren. Durch Hochgeschwindigkeitsphotos des Durchfliessens der Partikel in der Maschine wurden sofort einige der Ursachen für diese Anomalien aufgezeigt. Auf diesen Erkenntnissen beruhend wurde die Mühle neu gebaut und die Hochgeschwindigkeitsphotographie wird zur Untersuchung ihrer Leistung angewendet. Die angewandte Methode ist unkompliziert und es wird eine Fastax Kamera mit Geschwindigkeiten bis zu 1000 Aufnahmen/s verwendet. Die Hauptprobleme stammten von der Unzugänglichkeit des Objekts und der Beschaffung von genügend Licht, da das zu pulverisierende Material Kohle war.

A $500 award newly authorized by the National Electronics Conference will be presented during the 16th NEC Conference, Oct. 10–12 in the Hotel Sherman, Chicago, to the author of the best synoptic or tutorial paper presented during the previous years' Conference. The author's selection, organization and evaluation of material, plus scholastic level and clarity of presentation, are criteria for the new award. The NEC will also present a $500 award for the best original paper presented during the previous Conference, as it has done for many years past. Criteria for this award are originality, importance of contribution, clarity of presentation and scholastic level. The NEC Award of Merit and a check for $750 are given from time to time, honoring the author of a particularly influential paper presented during any Conference. The last Award of Merit was presented to Leon M. Brillouin for his paper, "A Theorem of Larmor and Its Importance for Electrons in Magnetic Fields."

It has also been announced that copies of the *NEC 1960 Proceedings* may be purchased during registration for the Conference at a price of $5.00. When ordered by mail the price is $6.00. The book contains 100 papers scheduled for presentation at the 16th Conference. Subjects include various phases of data gathering and transmission, computers, circuit and control theory, parametric devices, microelectronics, plasma physics and engineering management.

Additional information on the Conference appears in the July 1960 *Journal* (p. 502).

Speakers on the Photography in Space Program presented during the 69th Exposition of Professional Photography and the 8th Annual National Industrial Photographic Conference, held during August in Chicago, stressed the importance of education for professional photography and also called on the manufacturers of photographic supplies to produce better materials at lower cost. Jospeh H. Snyder, President, Color Corp. of America, New York and Tampa, Fla., moderator of the program, noted that during the past year there were not enough four-year science students graduated from photographic technology schools to meet the demand for photographers in missile and space programs. He suggested that industry sponsor more scholarships for technically inclined worthy high-school students.

An extensive collection of photographic antiques dating back to 1845 is offered for rental by the owner, Irving Browning, President of the Society of Cinema Collectors and Historians, 1845 Broadway, New York 23. Suggested to motion-picture, television and theatrical producers and set designers, the items may be rented separately, if desired, or as a collection. Items include a camera, possibly used by Daguerre, other antique still cameras, early motion-picture cameras, experimental projectors for 3-D and other special effects, and other curious and historical photographic devices.

Fundamental Research and Theories in Canning Machinery

C. C. Collier, Food Machinery and Chemical Corp., and J. J. Larish, Ansco, Div. of General Aniline and Film Corp., Binghamton, N. Y.

The canning industry has grown from an art to a high-speed production operation. This change has necessitated a parallel improvement in machinery design. To help speed fundamental research and development, Food Machinery and Chemical Corp. has made extensive use of high-speed motion pictures. One such project was a study of juice-filling operations, which resulted in improved, faster-flowing valves. Other studies included machines such as bean snippers, piston displacement fillers, corn huskers and corn cutters. Results from the studies include basic knowledge of equipment and operation and a number of new theories of operations.

Recherches et théories fondamentales dans le domaine des machines de mise en conserves

C. C. Collier, Food Machinery and Chemical Corp., et J. J. Larish, Ansco, Div. of General Aniline and Film Corp., Binghamton, N.Y.

L'industrie des conserves alimentaires, qui était à l'origine un art rudimentaire, est maintenant caractérisée par des opérations de fabrication à grande vitesse. Cette évolution a nécessité une amélioration parallèle dans la construction des machines employées. Afin d'accélérer les recherches fondamentales et développements de base, la Food Machinery and Chemical Corp. a fait un emploi considérable des films cinématographiques à grande vitesse. Un de ces projets a été l'étude des opérations de remplissage des jus, ce qui a abouti au perfectionnement de vannes à débit rapide. D'autres études ont porté sur des machines telles que les coupeuses de haricots, les remplisseuses à piston, les décortiqueuses et les coupeuses de maïs. Les résultats de ces investigations ont fait mieux comprendre le fonctionnement des machines en cause et ont contribué à l'élaboration d'un certain nombre de théories nouvelles sur les opérations en jeu.

Grundlegende Forschung und Theorien betreffend Konservenmaschinen

C. C. Collier, Food Machinery and Chemical Corp., und J. J. Laris, Ansco Div. of General Aniline and Film Corp., Binghamton, N.Y.

Die Konservenindustrie ist von einer Kunst zu einer Hochgeschwindigkeitsproduktion angewachsen. Dieser Wechsel machte eine gleichlaufende Verbesserung in der Konstruktion der Maschinen notwendig. Um zur Beschleunigung der grundlegenden Forschung und Entwicklung beizutragen, hat die Food Machinery and Chemical Corp. die Hochgeschwindigkeits-Kinematographie in weitem Masse herangezogen. Ein derartiges Projekt betraf die Untersuchung von Fruchtsaft-Abfülloperationen, welche zu besseren, Ventilen führte, die rascheres Fliessen erlauben. Andere Studien betrafen Maschinen wie z.B. Bohnenschneider, Füllmaschinen mit Zylinder und Kolben, Maishüllenentferner und Maisschneider. Zu den Ergebnissen der Studien gehört die grundlegende Kenntnis der Ausrüstung und ihrer Betätigung sowie eine Anzahl neuer Theorien über die Operationen.

A Variety of Marine Applications of High-Speed Photography

Daniel H. Lamb, Research Center, Outboard Marine Corp., Milwaukee, Wis.

The various products of the Outboard Marine Corp., all receive attention at the Research Center. Studies made by this group include noise reduction, vibration analysis and control, combustion study, ignition study, structural analysis, etc. In every one of these varied assignments high-speed photography has played an important part. One significant problem involving both noise and vibration is caused by the flexibility of the crankshaft and crankcase of the outboard motor. High-speed photography has assisted in analyzing the frequency, modes and amplitudes of the motion involved.

The high-speed camera was used very effectively to analyze the damaging action which takes place when an outboard motor strikes an object in the water. This work was associated with the development of hydraulic shock absorbers on the high-powered outboards. Lawn mowers and chain saws have received the attention of the high-speed camera in analyzing the cutting action of the respective blades. Other problems involving these two products have also been studied by this means. These and other applications of the Fastax camera are illustrated by motion pictures.

Une variété d'applications marines de la photographie à grande vitesse

Daniel H. Lamb, Research Center, Outboard Marine Corp., Milwaukee, Wisconsin

Les divers produits de l'Outboard Marine Corp. font tous l'objet d'investigations au Centre de Recherches. Les études faites par ce groupe portent sur l'atténuation des bruits, l'analyse et la maîtrise des vibrations, l'étude de la combustion, l'étude de l'allumage, l'analyse structurale, etc. Dans chacune de ces investigations de nature variée, la photographie à grande vitesse a joué un rôle essentiel. Un problème important qui met en jeu tant le bruit que les vibrations est du à la flexibilité du vilebrequin et du carter des moteurs hors bord. La photographie à grande vitesse a permis d'analyser la fréquence, le mode et l'amplitude des mouvements engendrés.

On a utilisé avec des résultats très satisfaisants la caméra à grande vitesse pour analyser l'effet détériorateur qui se produit quand un moteur hors bord heurte un objet dans l'eau. Ces travaux ont été associés à la réalisation des amortisseurs de chocs de type hydraulique sur les hors-bord de grande puissance. La caméra à grande vitesse a aussi servi, pour les tondeuses de gazon et les scies à dents articulées, à analyser l'action coupante des lames respectives. D'autres problèmes concernant ces deux instruments ont été étudiés par ce même moyen. Ces applications de la caméra Fastax, et d'autres encore, sont illustrées par des films cinématographiques.

Verschiedene Anwendungen der Hochgeschwindigkeitsphotograhie für Marinezwecke

Daniel H. Lamb, Research Center, Outboard Marine Corp., Milwaukee, Wis.

All die verschiedenen Produkte der Outboard Marine Corp. werden von dem Research Center mit Interesse beobachtet. Zu den von dieser Gruppe gemachten Studien gehören solche über Geräuschverminderung, Analyse und Verminderung der Vibration, Untersuchungen über Verbrennung und Zündung, Strukturanalysen usw. Bei all diesen verschiedenen Aufgaben hat die Hochgeschwindigkeitsphotographie eine bedeutende Rolle gespielt. Ein wichtiges Problem, sowohl hinsichtlich des Lärms als der Vibration, war die Folge der Biegsamkeit von Kurbelwelle und Kurbelwellengehäuse des Aussenbordmotors. Die Hochgeschwindigkeitsphotographie trug dazu bei, die Frequenz, Moden und Amplituden der betreffenden Bewegung zu analysieren.

Sie zeigte ihre Nutzbarkeit auch beim Untersuchen der schädigenden Bewegung die stattfindet, wenn der Aussenbordmotor auf ein im Wasser befindliches Objekt auftrifft. Diese Arbeit geschah in Verbindung mit der Entwicklung hydraulischer Stossdämpfer für starke Aussenbordmotoren. Die Schneidwirkung der Klingen von Rasenmähern und Kettensägen wurde mit Hilfe dieser Kamera analysiert und andere Probleme dieser beiden Produkte wurden auf die gleiche Weise untersucht. Diese und andere Anwendungen der Fastax Kamera werden durch Kine-Bilder illustriert.

—— FRIDAY 2:00 P.M. SESSION: Values and Problems in High-Speed Photography

Method for Analysis of High-Speed Films

Franz Topfer, Comité National Belge d'Optique, International Scientific Film Assn., Liège, Belgium

For plotting time-motion curves from high-speed films the feeding step of the tracing paper must be exactly proportional to the time intervals between frames. For this purpose timing light marks ("pips") are made on the film during the camera run; the feeding steps of the tracing paper must be determined by means of preliminary measuring of frame rate. This procedure is very inconvenient. A very simple method has been devised for eliminating the need for the

Procédé d'analyse de films enregistrés a haute fréquence

Franz Topfer, Comité National Belge d'Optique, Liège, Belgique

Pour l'analyse des films pris avec une caméra à haute fréquence et, en particulier, pour relever des diagrammes temps/mouvement, il est nécessaire que l'avancement du papier à diagramme soit rigoureusement proportionnel aux intervalles de temps entre les images du film. A cet effet, le film est muni, pendant la prise de vues, de marques de temps sous forme de traits (tops). Pour déterminer l'avancement à donner, d'image en image, au papier à diagramme, il est nécessaire de procéder préalablement à des

Verfahren zur Auswertung von Hochfrequenz-Filmen

Franz Topfer, Comité National Belge d'Optique, Liège, Belgien

Für die Auswertung von Hochfrequenz-Filmen und im Besonderen für die Aufzeichnung von Zeit/Weg-Kurven ist es notwendig, dass der Vorschub des Diagrammpapiers dem jeweiligen Zeitabstand zwischen der einzelnen Bildern genau proportional ist. Zu diesem Zwecke wird der Film bei der Aufnahme gewöhnlich mit Strich-Zeitmarken versehen. Der Vorschub des Diagrammpapiers muss durch vorherige Bestimmung der sich dauernd ändernden Bildfrequenz festgelegt werden. Es wird ein sehr einfaches

Rollo Gillespie Williams has been elected a Fellow of the Illuminating Engineering Society. He has long been a Fellow of the Illuminating Engineering Society of Great Britain. Announcement was made Sept. 12 at the National Convention in Pittsburgh, Pa. He was also elected Vice-Chairman of the IES New York Section for a two-year term beginning in 1960. He is a member of the IES Committee on Theatre & Television Lighting and Chairman of the Subcommittee on Lighting of Educational and Community Theatre Stages, and is Chairman of a U.S. National Committee of the International Commission on Illumination for the study of motion-picture and television studio lighting and stage lighting. Mr. Williams is a member of the SMPTE Committee on Television Studio Lighting and is the author of a number of papers published in the *Journal*, the most recent being "Evaluation and Control of Brightness Levels for Television Studio Lighting," published in the July 1960 issue of the *Journal*.

Meier Sadowsky has been elected President of Continental Electronics Corp. of California, a Los Angeles firm specializing in the development and production of special purpose cathode-ray tubes and replacement TV picture tubes. Mr. Sadowsky had served previously as Executive Vice-President of the firm's Industrial and Government Division. For a number of years he has been engaged in research and development in the fields of transistors and cathode-ray tubes. He is the author of a number of papers published in technical journals. He presented a paper on "Cathode-Ray Tube and Photographic Film Characteristics Related to Film Recording for Television" at the Society's 1960 Spring Convention in Los Angeles which is scheduled for publication in an early issue of the *Journal*.

An unusual Industrial TV study aimed at discovering the causes of excessive wear on the tracks of the Rhodesian Railways was made possible by the installation of a closed-circuit system by Marconi Wireless Telegraph Company. A closed-circuit TV camera was mounted on a locomotive only a few inches from the wheels and the track and a monitor placed in a compartment on the train so that the action of the wheels could be observed by railway officials and engineers. The study was made because of abnormal wear on sharp curves of the railway track between Umtali and Salisbury. The placement of the camera by means of special brackets enabled continuous observation of the motion of the wheels.

Newly elected officers of the National Audio-Visual Association are: Harvey W. Marks, President; Mahlon H. Martin, Jr., First Vice-President; Harold A. Fischer, Second Vice-President; Robert P. Abrams, Secretary; Earl Harpster, Treasurer. Announcement was made at the Association's 20th Annual convention held Aug. 6–9 in Chicago.

preliminary measuring of changes in frame rate. A timing instrument with rotating scale is photographed on every frame. The film analyzer is equipped with an idle replica of the timer scale, the axis of which is coupled with that of a sprocket drum which controls the feed of the perforated tracing paper.

At every switch of frame it is now merely necessary to transport the tracing paper until the timer scale replica is in the same position as that shown on the projected frame. In this way, the feeding step of the tracing paper is automatically proportional to the time interval between projected and preceding frame. The ratio of the angle of rotation of the sprocket drum and that of the timer scale replica can be varied stepwise or continuously. Thus it is possible to preset the time scale of the time-motion curve, e.g. 1 mm representing 1 msec.

mesures fastidieuses pour établir les variations de la fréquence d'enregistrement, qui est essentiellement variable. L'auteur décrit un procédé très simple, permettant de supprimer ces mesures préalables. Sur chaque image est enregistrée une partie d'un cadran tournant à vitesse déterminée. L'appareil pour la lecture des films est muni d'une replique exacte du cadran, l'axe de laquelle est couplé avec celui d'un tambour denté contrôlant l'avancement du papier à diagramme perforé.

A chaque image apparaissant sur l'écran, il suffit de tourner le bouton commandant le transport du papier jusqu'à ce que la replique de cadran se trouve exactement dans la même position que le cadran apparaissant sur l'image. De cette manière, l'avancement du papier à diagramme est, à tout moment, rendu automatiquement proportionnel à l'intervalle de temps entre l'image visible sur l'écran et la précédente. Le rapport entre les angles de rotation du cadran et du tambour denté peut être modifié à volonté. Il est donc possible de fixer d'avance l'échelle de temps du diagramme en faisant correspondre, par example, 1 mm de l'abscisse à 1 ms.

Verfahren beschrieben, welches diese umständliche Vorarbeit unnötig macht. Auf jedem Bild wird eine rotierende Zeitskala aufgenommen. Das Film-Auswertegerät ist mit einer Nachbildung dieser Zeitskala versehen, die mit der Achse einer Zahnwalze gekuppelt ist, welche den Vorschub des perforierten Diagrammpapiers kontrolliert.

Bei jedem neuen Bild, welches auf dem Bildschirm erscheint, genügt es den Transportknopf des Diagrammpapiers so weit zu drehen, bis die Nachbildung der Zeitskala sich in der gleichen Stellung befindet wie die auf dem Filmbild erscheinende. Somit wird bewerkstelligt, dass der Vorschub des Diagrammpapiers jederzeit automatisch dem Zeitabstand zwischen dem projizierten und dem vorhergehenden Filmbild proportional ist. Das Verhältnis der Drehwinkel der Zahnwalze und der Skalennachbildung kann absatzweise oder kontinuierlich eingestellt werden. Es ist daher möglich, den Zeitmasstab der Zeit/Weg-Kurve beliebig zu wählen, etwa derart, dass 1 Millimeter der Abszisse einer Millisekunde entspricht.

Some Philosophical Aspects of High-Speed Photographic Instrumentation

MORTON SULTANOFF, Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

The sources of uncertainty in the interpretation of photographic records obtained by many of the techniques employed in high-speed photographic instrumentation are examined. The need for understanding of the events being studied in terms of physics is shown to be an essential requirement in the analysis and association of the photographically recorded luminous output to that event.

Difficulties which arise in the analysis of rotating-mirror camera streak-records are described and the simultaneous use of associated equipment to overcome these difficulties is recommended. The need for "mental conditioning" to avoid the pitfalls of misinterpreted high-speed photographic recordings is demonstrated. The nature of the cameras, the recorded light, and the physical characteristics of the events being studied must be carefully analyzed to avoid typical misinterpretations, several of which are illustrated in this paper.

Certains aspects philosophiques des techniques photographiques à grande vitesse

MORTON SULTANOFF, Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland

L'auteur examine les éléments d'incertitude dans l'interprétation des enregistrements photographiques obtenus par un grand nombre des techniques mises en jeu dans l'emploi des instruments photographiques à grande vitesse. La nécessité d'une compréhension nette des processus étudiés en termes de physique est indiquée comme une condition essentielle dans l'analyse et dans l'association du débit lumineux enregistré électriquement avec le processus en cause.

L'auteur décrit les difficultés qui se présentent dans l'analyse des enregistrements à stries obtenus avec la caméra à miroir tournant et recommande l'emploi simultané d'un équipement auxiliaire pour surmonter ces difficultés. Il démontre aussi l'importance d'un "conditionnement mental" pour éviter les dangers d'une fausse interprétation des enregistrements photographiques à grande vitesse. La nature des caméras utilisées, la lumière enregistrée et les caractéristiques physiques des processus étudiés doivent être analysés avec soin pour éviter les erreurs d'interprétation courantes, dont plusieurs sont illustrées dans le présent mémoire.

Einige philosophische Betrachtungen über die Apparate der Hochgeschwindigkeits-Photographie

MORTON SULTANOFF, Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

Es werden die Quellen der Ungewissheit geprüft, die sich bei der Interpretation photographischer Aufnahmen ergeben, die nach vielen der mit photographischen Hochgeschwindigkeits-Instrumenten angewandten Methoden erzielt werden. Es wird gezeigt, dass es absolut notwendig ist die zu studierenden Ereignisse physikalisch zu verstehen, wenn man ihre photographisch aufgenommenen Lichtspuren analysieren und in die rechte Beziehung bringen will.

Es werden die Schwierigkeiten beschrieben, die sich bei der Analyse von Schlierenaufnahmen ergeben, die mit Rotorspiegel-Kameras gemacht wurden und es wird der gleichzeitige Gebrauch verwandter Geräte empfohlen, um diese Schwierigkeiten zu vermeiden. Es wird die Notwendigkeit für eine "geistige Vorbereitung" bewiesen, um die Fallen falsch ausgelegter photographischer Hochgeschwindigkeitsaufnahmen zu vermeiden. Man muss die Natur der Kameras, des aufgenommenen Lichts und die physikalischen Eigenschaften der untersuchten Ereignisse sorgfältig analysieren um typische Falschauslegungen zu vermeiden, von denen einige in diesem Artikel illustriert werden.

What is the Sensitivity of a Photographic System

FRED H. PERRIN, Research Laboratories, Eastman Kodak Co., Rochester, N. Y.

The term "sensitivity" is ordinarily defined as the exposure required to produce a certain density, usually low, in the developed image. Such a definition is not to the point when the purpose of the photographic system is solely to transmit information, in which case a concept that has been termed *informational sensitivity* is required. This quantity varies directly with the ratio of the density change of the corresponding exposure change and inversely with the product of the Selwyn granularity (root-mean-square density variation arising from granularity multiplied by the diameter of the scanning aperture) and the diameter of the spread function of the photographic system.

The scale of the negative required to transmit a certain amount of information is proportional to the square root of the product of granularity

Que faut-il entendre par la sensiblité d'un système photographique?

FRED H. PERRIN, Research Laboratories, Eastman Kodak Co., Rochester, N.Y.

Le terme "sensibilité" est habituellement défini comme représentant l'exposition nécessaire pour obtenir une densité donnée, généralement peu élevée, dans l'image développée. Une telle définition n'est pas rigoureusement juste quand l'objet du système photographique est uniquement de transmettre des informations; dans ce cas, il est nécessaire d'avoir recours à une notion modifiée qui a reçu le nom de *sensibilité informative*. Cette quantité varie en fonction directe du rapport entre le changement de densité et le changement correspondant d'exposition et en fonction inverse du produit de la granularité Selwyn (variation de densité due à la granularité et calculée par carré moyen et racine, multipliée par le diamètre de l'ouverture d'exploration) et du diamètre de la fonction dispersion du système photographique.

L'échelle du négatif nécessaire pour transmettre une certaine quantité d'informations est proportionnelle à la racine carrée du produit de la granularité par le diamètre de la fonction

Was ist die Lichtempfindlichkeit einer photographischen Einrichtung?

FRED H. PERRIN, Research Laboratories, Eastman Kodak Co., Rochester, N.Y.

Der Ausdruck "Lichtempfindlichkeit" wird gewöhnlich als die Belichtung definiert, die notwendig ist um eine — gewöhnlich geringe — Dichte im entwickelten Bild zu erzielen. Wenn der Zweck der photographischen Anlage ausschliesslich der ist Angaben zu übermitteln, ist diese Definition nicht ganz richtig und es wird ein Begriff erfordert, der als "*Angaben-Lichtempfindlichk-it*" bezeichnet wurde. Diese Zahl ändert sich im gleichen Verhältnis wie das der Dichtenänderung zur entsprechenden Belichtungsänderung und im umgekehrten Verhältnis zu dem Produkt der Selwyn-Granularität (Wurzel aus dem Durchnitt der Quadrate der Dichtenänderung die von der Granularität herrührt, multipliziert mit dem Durchmesser der abtastenden Öffnung) und dem Durchmesser der ausbreitenden Wirkung der photographischen Apparatur.

Der Skalenwert des Negativs, das eine bestimmte Menge von Angaben zu übermitteln hat, ist proportional der Quadratwurzel aus dem

A curious reader can read "between the lines" of the *SMPTE Directory for Members* many interesting and unusual stories about jobs and careers. Such a "between the lines" story is that of Harold R. Power, Motion-Picture Engineer with the State Film Centre of Victoria, Australia. Besides the usual duties of an engineer he acts as part-time lecturer in documentary film and cinematography at the Royal Melbourne Technical College and supervises a mobile projection service and information service.

Some interesting things are going on "down under" in the area of documentary films. The State Film Centre is a section of the Premier's Department, Victoria, and is supervised by the Victorian Documentary Film Council, an independent advisory body. The recently issued 1959 Report states that, "for the third year in succession, since television came to Victoria, documentary films have not only held the interest of people in all parts of Victoria, but have been used with more specific purpose than formerly." Among new ventures sponsored by the Centre during 1959 was a screening of documentary films, held in the Alexandra Gardens. A Debrie 16mm arc projector mounted on a light trailer was used to give a 24-ft picture.

One of the services offered by the Centre is technical advice given to borrowers, which has proved an important factor in the safe, economical use of 16mm film and equipment.

Norelco Universal 70/35mm projection equipment is now available from theater supply dealers throughout the United States, according to a joint announcement by Niels Tuxen of North American Philips Co., manufacturer and national distributor of Norelco equipment, and George P. Skouras of the Todd-AO Corp. who, for many years, exclusively handled the sale of this equipment direct to exhibitors. The announcement noted the continuing trend toward 70mm. As reported in the July 1960 *Journal* (p. 514), more than 100 projectors have been installed in the United States and Canada. The equipment is available in Canada through Philips Electronic Industries, Ltd., Toronto.

Also to be made available at a future date through theater supply dealers are the Philips FP7 35mm projector, the new FP 20-S "shutterless" 35mm projector with pulsed gas-discharge light source, as well as portable 35mm and 16mm professional projectors.

The appointment of three foreign dealers has been announced by Magnasync Corp., North Hollywood, bringing its worldwide representation to a total of 22 firms. The new dealers are William Over & Co., Pvt. Ltd., Salisbury, South Rhodesia; Photo Agencies Pty. Ltd., Johannesburg, South Africa; and Kerridge Odean Industries, Auckland, New Zealand. At the same time all previously established representation in Cuba was completely severed. The firm designs and manufactures magnetic recording systems for professional and amateur use and for industrial instrumentation applications.

and spread-function diameter, so this product determines the length of the camera required. Informational sensitivity indicates, for this negative scale, the relative exposure required. The concept is applied to actual emulsions, and the method of extending it to a moving object is indicated.

dispersion, de sorte que ce produit détermine la longueur de la caméra nécessaire. La sensibilité informative indique, pour cette échelle de négatif, l'exposition relative à employer. Cette notion est appliquée aux émulsions actuelles, et le moyen d'étendre son application à un objet en mouvement est indiqué par l'auteur.

Produkt von Granularität und Ausbreitungswirkungs-Durchmesser und es ist so dieses Produkt, das die Länge der erforderlichen Kamera bestimmt. Für diese Negativskala gibt die Angaben-Lichtempfindlichkeit die relative Belichtung. Der Begriff wird für gegenwärtige Emulsionen angewendet und es wird die Methode erwähnt wie man ihn für ein bewegliches Objekt verwenden kann.

Study of Resolution Limits in High-Speed Recording Instruments

T. E. Holland, Beckman & Whitley, Inc., San Carlos, Calif.

An attempt has been made to classify various instruments employed in high-speed recording with respect to inherent spatial and temporal resolution limits. In general, the design of a high-speed recording device involves a compromise in spatial resolution as the speed is increased. The interesting number of frames or the useful information storage can be estimated from the resolution characterizing the individual frame.

Analysis for resolution criteria for the basic rotating-mirror framing camera is given in some detail. Information is presented in tables on aperture ratio, resolution, framing rate, effective exposure time, and light source requirements as determined by the rotating-mirror size and object velocity. From this information, curves can be obtained relating the mean resolution per frame with the magnification-object velocity product (*mv*). By means of these curves, comparisons are made for the (*mv*) value coverage of the various types of cameras.

This analysis suggests that, because of the low inherent resolution of image dissectors (and certain electrooptical devices) the most efficient use of these devices would be in the very high-speed range, i.e., large values of (*mv*). Similarly, with higher resolution content, the rotating-mirror and rotating-prism moving film cameras are useful for small (*mv*) values.

Une étude des limites de résolution dans les instruments d'enregistrement à grande vitesse

T. E. Holland, Beckman & Whitley, Inc., San Carlos, Californie

Une tentative a été faite pour classer les divers instruments employés dans l'enregistrement à grande vitesse au point de vue des limites de résolution inhérentes tant dans l'espace que dans le temps. En général, la construction d'un appareil d'enregistrement à grande vitesse comporte un certain compromis dans la résolution spatiale quand la vitesse est augmentée. On peut estimer le nombre intéressant d'images ou l'emmagasinement d'informations utiles par la résolution qui caractérise l'image individuelle.

L'auteur donne des détails sur la détermination analytique des critères de résolution pour la caméra-type multi-images à miroir tournant. Des indications sont données sous forme de tableaux sur le rapport d'ouverture, la résolution, la cadence d'images, le temps d'exposition effectif et les conditions de source lumineuse, selon les dimensions du miroir tournant et la vitesse de l'objet. D'après ces renseignements, on peut tracer des courbes mettant en relation la résolution moyenne par image avec le produit de l'amplification par la vitesse de l'objet (av). Au moyen de ces courbes, on fait des comparaisons entre les divers types de caméras pour leur échelle respective de valeur (av).

Cette analyse suggère que, en raison de la faible résolution inhérente des dissecteurs d'image (et de certains appareils électro-optiques), l'emploi le plus efficace de ces appareils serait dans le domaine des très grandes vitesses, c'est-à-dire des valeurs (av) élevées. De même, avec un haut indice de résolution, les films cinématographiques à miroir tournant ou à prisme tournant sont utiles pour de faibles valeurs (av).

Untersuchung der Resolutionsgrenzen von Hochgeschwindigkeits-Aufnahmegeräten

T. E. Holland, Beckman & Whitley, Inc., San Carlos, Kalifornien

Es wurde versucht verschiedene Geräte für Hochgeschwindigkeitsaufnahme hinsichtlich ihrer raum- und zeitmässigen Resolutionsgrenzen zu klassifizieren. Im allgemeinen bedingt der Entwurf einer Hochgeschwindigkeits-Aufnahmevorrichtung bei steigender Geschwindigkeit ein Kompromiss hinsichtlich der raummässigen Resolution. Es lässt sich aus der Resolution der einzelnen Aufnahme die Aufnahmenzahl oder die nützliche Datenaufspeicherung abschätzen.

Eine Analyse der Resolutionskriterien für die grundlegende Bildreihenkamera mit rotierendem Spiegel wird mit vielen Einzelheiten gegeben. In der Form von Tabellen werden Daten über relative Öffnung, Resolution, Bildgeschwindigkeit, wirksame Belichtungszeit sowie die notwendige Beleuchtung je nach der Grösse des rotierenden Spiegels und der Geschwindigkeit des Objekts gegeben. Aus diesen Angaben lassen sich Kurven darstellen über die Beziehungen zwischen der durchschnittlichen Resolution pro Aufnahme und dem Produkt von Vergrösserung und Objektgeschwindigkeit (mv). Mittels dieser Kurven lassen sich Vergleiche der (mv)-Werte verschiedener Arten von Kameras machen.

Diese Analyse empfiehlt, wegen der ihnen eigenen geringen Resolution von Bild-Disektoren (und gewissen elektro-optischen Vorrichtungen) ihre zweckmässigste Verwendung auf dem Gebiet der sehr hohen Geschwindigkeiten d.h. hohen (mv)-Werten liegen würde. In gleicher Weise sind, bei höherem Resolutionsgehalt, Kameras mit bewegtem Film mit rotierendem Spiegel und rotierendem Prisma für niedrige (mv)-Werte nützlich.

Value Received — The Use of High-Speed Photographic Techniques in Research and Industry

R. Wayne Anderson, Dow Chemical Co., Midland, Mich.

The economics of high-speed photography as a basic tool in research and industry will be discussed and specific examples of dollar-and-cent saving due directly to the use of high-speed photography will be used. A spot-check survey of nonmilitary users of high-speed cameras and how they are used will be presented to show the tremendous increase in use of high-speed techniques in the last 10 years and the potential use of high-speed photography as a basic industrial and research tool. Examples of the wide variety of uses of high-speed photography in research and industry will be shown. A discussion of the types of cameras generally used in industry and the general trend to development of higher-speed cameras, simpler, more effective light sources and analytical equipment will lead to the conclusion that high-speed photography is becoming more and more important as a basic, economical tool in research and industry.

Valeur reçue — L'emploi des techniques photographiques à grande vitesse dans le domaine des recherches et de l'industrie

R. Wayne Anderson, Dow Chemical Co., Midland, Michigan

On se propose d'examiner les aspects économiques de la photographie à grande vitesse comme moyen de travail essentiel dans le domaine des recherches et de l'industrie et l'on donnera des exemples précis d'économies en dollars et cents attribuables directement à l'utilisation de la photographie à grande vitesse. On présentera les résultats d'une enquête auprès des utilisateurs non militaires de caméras à grande vitesse et notamment sur le mode d'emploi de ces appareils afin de montrer l'accroissement formidable de l'utilisation des techniques à grande vitesse au cours des dix dernières années et les applications potentielles de la photographie à grande vitesse comme méthode de base dans l'industrie et dans le domaine des recherches. On donnera des exemples de la grande variété des emplois de la photographie à grande vitesse dans ces domaines. Un examen des types de caméras généralement utilisées dans l'industrie et de la tendance croissante vers la réalisation de caméras à vitesse accélérée, ainsi que de sources lumineuses et instruments analytiques plus simples et plus efficaces, aboutira à la conclusion que la photographie à grande vitesse prend une place de plus en plus importante dans le domaine des recherches et de l'industrie comme moyen de travail à la fois économique et fondamental.

Wert erhalten—der Gebrauch photographischer Hochgeschwindigkeitsmethoden in Forschung und Industrie

R. Wayne Anderson, Dow Chemical Co., Midland, Mich.

Die wirtschaftliche Seite der Hochgeschwindigkeits-Photographie als grundlegendes Gerät in Forschung und Industrie wird erörtert und es werden spezifische Beispiele der Ersparnisse in Dollars und Cents, die direkt auf die Verwendung der Hochgeschwindigkeitskameras zurückzuführen sind, gebracht. Stichprobenweise wird eine Übersicht der nichtmilitärischen Gebraucher von Hochgeschwindigkeitskameras und der Art der Verwendung gegeben werden, um das enorme Ansteigen der Anwendung von Hochgeschwindigkeitsmethoden in den letzten 10 Jahren und die noch möglichen Anwendungen der Hochgeschwindigkeits-Photographie als grundlegendes Industrie- une Forschungsgerät zu zeigen. Es werden Beispiele für die Verschiedenartigkeit der Anwendungsmöglichkeiten der Hochgeschwindigkeits-Photographie in Forschung und Industrie gebracht werden. Eine Besprechung der in der Industrie hauptsächlich verwendeten Kameratypen und der allgemeinen Richtung bezüglich der Entwichlung von Kameras höherer Geschwindigkeit, einfacherer und leistungsfähigerer Lichtquellen und analytischer Geräte wird zu der Schlussfolgerung führen, dass die Hochgeschwindigkeits-Photographie als grundlegendes wirtschaftliches Werkzeug für Forschung und Industrie von immer grösserer Bedeutung wird.

Biographical Note

Elsie L. Garvin

Miss Elsie Garvin, longtime head of the Research Library at Kodak Park Works and friend and colleague of hundreds of laboratory scientists, retired July 8, 1960, after forty years with Eastman Kodak Company.

As Librarian for Kodak Research Laboratories, Miss Garvin was in charge of an internationally famous reference center on photographic and related sciences. When she became Librarian, in 1923, there were 5000 technical volumes in the library; at the time of her retirement the library contained 30,000 books and thousands of articles and reports on microfilm.

Miss Garvin was born in Danville, Vermont, and was graduated from the University of Vermont in 1920. After her graduation she joined Eastman Kodak Company as Editor of the Monthly Abstract Bulletin of Kodak Research Laboratories. Shortly thereafter she became Editor of Abridged Scientific Publications and Monographs, a post she held until her appointment as Librarian.

Long active as Chairman of the Science-Technology group of the national Special Libraries Association, she helped organize a Western New York Chapter in 1945. She served as President of the Chapter for a two-year term beginning in 1952. She is also a member of the Monroe County Library Association; the Chemical Literature Division of the American Chemical Society; and the American Association for University Women.

Among other publications to her credit is an extensive bibliography on high-speed photography, published in 1951, of which she is co-author. In 1955 she undertook a revision of this volume for special distribution at the Third International Congress on High-Speed Photography held in London.

During an interview at the time of her retirement, Miss Garvin noted that a recognizable trend in recent years has been the importance of translations of scientific reports from Russian and Japanese. The library's translations of articles from all foreign languages, which in 1923 was "only a handful," has grown to several thousand. Another addition to the library, which she mentioned as being of importance, is the large collection of government reports on scientific subjects.

Her plans for her retirement include travel and special attention to her favorite sports of bowling and golf.

Obituaries

Peter Mole

Peter Mole, President of Mole-Richardson Co. of Hollywood, died August 2, 1960, at La Jolla, Calif., at the age of 68. He was Past-President of the SMPTE (1951-52) and recipient of the Progress Medal (1948).

He was born in Termini, Sicily, Italy, in 1891 and came to the United States in 1907. He became a naturalized citizen in 1930. He was graduated an electrical engineer from Union College in 1915 and from 1915 until 1923 he was design engineer for General Electric Co. where he was active in the development of the General Electric searchlight and a high-intensity rotating carbon-arc theater projection lamp.

In 1923 he left General Electric and moved to California where he was General Manager of Creco, Inc., and soon became interested in motion-picture studio light-

FRIDAY 3:45 P.M. SESSION: Applications — Survey Papers

High Speed Camera Facilities

DAVID C. OAKLEY, Lawrence Radiation Laboratory, University of California, Livermore, Calif.

The high-speed camera facilities at the University of California Ernest O. Lawrence Radiation Laboratory include five firing sites using framing cameras with framing rates up to 3.3 million/sec, Kerr cell cameras of 0.005μ/sec exposure time, and smear cameras with writing rates up to 15 mm/μsec. These cameras are coordinated with other techniques for simultaneous recording. Techniques have been developed for using two discontinuously writing cameras simultaneously. High explosive light sources are used and electronic light sources have been developed that allow photography in color at 1.2 million frames/sec. Termination of the record is done with a simple mirror cutoff which takes only three μsec to go from open to closed.

The camera arrangements and auxiliary equipment have been designed for maximum flexibility and fail-safe operation. The safety of personnel is very carefully considered. Annoyance of nearby residents has been minimized. This work was supported by the U.S. Atomic Energy Commission at Lawrence Radiation Laboratory.

Un exemple d'installation de caméras à grande vitesse

DAVID C. OAKLEY, Lawrence Radiation Laboratory, University of California, Livermore, Californie

L'installation de caméras à grande vitesse du Laboratoire de Radiation Ernest O. Lawrence de l'Université de Californie consiste en cinq emplacements de prise de vues qui utilisent des caméras multi-images à cadences d'images allant jusqu'à 3,3 million/s, des caméras à cellule Kerr à temps d'exposition de 0,005 μs et des caméras maculeuses à vitesses d'enregistrement maxima de 15 mm/μs. Ces caméras sont coordonnées à d'autres techniques en vue d'un enregistrement simultané. On a mis au point des techniques qui permettent d'employer simultanément deux caméras à enregistrement intermittent. On utilise des sources de lumière à explosif brisant et l'on a perfectionné des sources lumineuses de type électronique qui permettent de photographier en couleur à des cadences de 1,2 million d'images/s. La fin de l'enregistrement est commandée par un simple disjoncteur à miroir qui ne prend que 3 μs entre l'ouverture et la fermeture.

Les systèmes de caméras et l'équipement auxiliaire ont été conçus en vue d'un maximum de flexibilité et de sûreté de fonctionnement. On a pris grand soin d'assurer la sécurité du personnel. On a réduit au minimum les risques d'ennuyer les voisins. Ces travaux ont été patronés par la Commission d'Energie Atomique des Etats-Unis au Laboratoire de Radiation Lawrence.

Hochgeschwindigkeitskamera-Anlagen

DAVID C. OAKLEY, Lawrence Radiation Laboratory, University of California, Livermore, Kalifornien

Zu den Hochgeschwindigkeitskamera-Anlagen des University of California Ernest O. Lawrence Radiation Laboratory gehören fünf Schiessplätze, die Bildreihenkameras mit Bildfrequenzen bis zu 3,3 Millionen Aufnahmen/s benützen, Kerrzellenkameras mit Belichtungszeiten von 0,005 s und "Schmier"-Kameras mit Aufzeichnungsgeschwindigkeiten bis zu 15 mm je Mikrosekunde. Diese Kameras werden mit anderen Methoden für gleichzeitige Aufzeichnungen koordiniert. Es wurden Methoden entwickelt, um zwei nichtkontinuierlich aufzeichnende Kameras gleichzeitig zu verwenden. Man verwendet Sprengstoff-Lichtquellen und es wurden elektronische Lichtquellen entwickelt, welche Farbphotographie mit 1,2 Millionen Aufnahmen/s ermöglichen. Die Aufzeichnung wird durch einen einfachen Spiegelabschalter beendet, der nur drei Mikrosekunden braucht um von offen auf geschlossen zu gehen.

Die Anordnungen der Kameras und des Zubehörs wurde im Hinblick auf möglichst vielseitige Verwendbarkeit und verlässlichen Betrieb entworfen. Der Sicherheit des Personals wurde grosses Augenmerk geschenkt. Die Belästigung der Nachbarschaft wurde auf ein Minimum herabgesetzt. Diese Arbeit wurde durch die U.S. Atomic Energy Commission beim Lawrence Radiation Laboratory unterstützt.

The Evolution of Techniques for Ultra High-Speed Photography and Cinematography at the Laboratoire Central de l'Armement Since the Paris Meeting of 1954

PAUL DEVAUX, Laboratoire Central de l'Armement, Arcueil, France

Well before the war of 1939–1945 the Laboratoire Central de l'Armement with its Engineer-General Libessart was already interested in techniques for ultra high-speed photography and cinematography. In 1946, after an interruption of several years, a new team was put on this subject. The period from 1946 to 1954 was utilized to train engineers and technicians in these very special techniques, mainly in the area of study rather than of practice. The Paris Meeting of 1954 marked the end of this period of adaptation and the new orientation was towards the following objectives: Research on the precision limits of different types of existing equipment, development of new instruments and the establishment of new processes for industrial requirements which would lead to very reliable equipment of high performance and simple operation. The trends and accomplishments in the following two fields will be reviewed: Photography and cinematography by transparence and reflection of nonluminous objects, and the photography and cinematography of self-luminous objects.

L'évolution des techniques de photographie et de cinématographie ultra-rapide au Laboratoire Central de l'Armement depuis le Congrès de Paris de 1954

PAUL DEVAUX, Laboratoire Central de l'Armement, Arcueil, France

Bien avant la guerre 1939–1945, le Laboratoire Central de l'Armement avec l'Ingénieur Général Libessart, s'intéressait déjà aux techniques de photographie et cinématographie ultra-rapide. Après une interruption de plusieurs années, une nouvelle équipe fut mise sur ce sujet on 1946. La période 1916–1954 fut employée à former ingénieurs et techniciens à ces techniques très spéciales en se cantonnant sur le plan étude avec peu de réalisations. Le Congrès de Paris en 1954 marquait la fin de cette période d'adaptation et l'orientation vers les objectifs suivants: recherche des limites de précision des différents types d'équipements existants, création d'appareillages nouveaux, et mise en place de procédés de réalisation industrielle devant aboutir à des équipements de grande securité joignant performances élevées et service simple. Les tendances et réalisations correspondants seront passées en revue dans les deux domaines suivants: photographie et cinématographie d'objets non lumineux, par transparence et réflexion; photographie et cinématographie d'objets lumineux par eux-mêmes.

Die Evolution der Methoden für Höchstgeschwindigkeits-Photographie und -Kinematographie beim Laboratoire Central de l'Armement seit der Pariser Konferenz im Jahre 1954

PAUL DEVAUX, Laboratoire Central de l'Armement, Arcueil, Frankreich

Schon lange bevor dem Kriege 1939–1945 hatte sich das Laboratoire Central de l'Armement mit Ingénieur-Général Libessart für die Methoden der Höchtgeschwindigkeits-Photographie und -Kinematographie interessiert. Nach einer Unterbrechung von mehreren Jahren wurde 1946 eine neue Gruppe von Leuten für diesen Gegenstand eingesetzt. Die Periode von 1946 bis 1954 wurde dazu benützt Ingenieure und Techniker in diesen ganz besonderen Methoden heranzubilden, wobei man sich auf das Studium beschränkte und nur wenige praktische Ergebnisse suchte.

Mit der Pariser Konferenz von 1954 endete dieser Abschnitt der Heranbildung und man wendete sich folgenden Zielen zu: Erforschung der Genauigkeitsgrenzen verschiedener Typen bereits existierender Geräte, Schaffung neuer Apparate und Festlegung der Vorgänge für industrielle Herstellung, die zu vollständig gefahrlosen Ausrüstungen hoher Leistungsfähigkeit bei einfacher Bedienung führen sollte. Die betreffenden Richtungen und Durchführungen auf folgenden zwei Gebieten werden besprochen werden: Die Photographie und Kinematographie nichtleuchtender Objekte im transparenten und reflektierten Licht und die Photographie und Kinematographie selbstleuchtender Objekte.

High-Speed Photography Applied to High-Speed Aerodynamic Research at the National Physical Laboratory

R. J. NORTH, National Physical Laboratory, Teddington, Middlesex, England

An account is given of the spark-light source systems used in Aerodynamics Division, National Physical Laboratory, for the photography of high

La photographie à grande vitesse appliquée aux recherches aérodynamiques à grande vitesse au National Physical Laboratory

R. J. NORTH, National Physical Laboratory, Teddington, Middlesex, Angleterre

Il est donné un compte rendu sur les systèmes de sources de lumière-étincelles utilisés dans la

Die Anwendung der Hochgeschwindigkeits-Photographie zur Erforschung der Hochgeschwindigkeits-Aerodynamik beim National Physical Laboratory

R. J. NORTH, National Physical Laboratory, Teddington, Middlesex, England

Es wird über die Blitzlichtanlagen berichtet, die

ing, first with the Metro-Goldwyn-Mayer Studios in the electrical department.

After receiving his groundwork training in actual production, he went to work for a motion-picture studio lighting equipment manufacturer. With his technical background plus experience in the studios he was prepared to enter the field of the manufacture of specialized equipment for an industry that was growing so fast its requirements changed almost from month to month. He soon joined forces with Elmer C. Richardson, another design engineer, and Fielding C. Coates, a studio chief electrician, and formed the Mole-Richardson Company.

The citation accompanying the Progress Medal on the occasion of the presentation noted:

"Mr. Mole's success in his chosen field is not due entirely to his ability to organize and operate an engineering and manufacturing organization to meet the needs of a unique industry. He has an unusual insight into the intangibles created by the art form in motion-picture production. He knows that engineering perfection must not transcend utilization in an industry where dramatic effect is the end result; yet he has been able to design and produce highly specialized lighting tools which satisfy both the artist and the engineer . . .

"Mr. Mole and his organization have pioneered in the development of lighting equipment during each of the successive stages in the advance of motion-picture lighting practice for more than twenty years. The wide use of their products manifests the success of their efforts and achievment. Future lighting developments which are currently being studied undoubtedly will reflect the benefits of Mr. Mole's experience as new and improved lighting becomes available for studio use.

"It is fitting to note that Mr. Mole's organization has been the recipient of four Certificate Awards from the Academy of Motion Picture Arts and Sciences, together with recognition by the United Nations Conference on International Organization."

He was the author of a number of papers published in the *Journal* (and earlier in the *Transactions*), one of the earliest being "The Use of Incandescent Equipment in Motion Picture Photography," in the April 1928 *Transactions*.

Alain Schuller

Alain Schuller, 74, died May 22, 1960, in Antwerp. At the time of his death he was Honorary Manager of Gevaert Photo-Producten, N.V., Mortsel, Antwerp. He held the degree of Doctor of Sciences and was a Chemical Engineer. He was born in Budapest, Hungary, in 1886. In 1912 Lieven Gevaert, founder of the Gevaert firm, invited him to join the firm to do research in the field of color photography. At the outbreak of World War I, Mr. Schuller joined the Hungarian Army as an officer. Shortly thereafter he was seriously wounded, and spent the remainder of the war working in a gun-cotton plant where he acquired a thorough knowledge of nitrocellulose. In 1925 he re-entered the Gevaert firm where he was placed in charge of the film-coating department where his knowledge of nitrocellulose proved of great value when Gevaert's coating facilities were changed from nitrocellulose base to nonflammable cellulose triacetate base. He retired in 1951.

C. E. Kenneth Mees

Dr. Mees died August 15 in Honolulu, Hawaii, at the age of 78. An Honorary Member of the Society, he was recognized internationally as an outstanding authority in the field of photographic science.

He was the author of about 160 publica-

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speed flows in wind tunnels and shock tubes. The systems consist of basic units which can be used in various ways, singly or in multiple units as in a Cranz-Schardin system. Some results obtained with such spark-light source systems are shown and briefly discussed. These include photographs taken on wind tunnels, shock tubes, and shock tunnels with schlieren, color-schlieren and schlieren-interferometer systems.

Division Aérodynamique du Laboratoire National de Physique pour la photographie des débits rapides dans les tunnels aérodynamiques et les tubes de choc. Ces systèmes se composent d'éléments de base qui peuvent être employés de manières diverses, isolément ou en combinaison, comme dans un système Cranz-Schardin. L'auteur indique et évalue brièvement certains des résultats obtenus avec ces systèmes de sources de lumière-étincelles. L'article contient des photographies de tunnels aérodynamiques, de tubes de choc et de tunnels de choc, prises au moyen de systèmes schlieren, schlieren en couleur et schlieren avec interféromètre.

bei der Aerodynamics Division, National Physical Laboratory zum photographieren von Hochgeschwindigkeits-Strömungen in Windtunnels und Stossröhren angewendet werden. Die Anlagen bestehen aus Grundeinheiten, die in verschiedener Weise, entweder einzeln oder in Mehrfacheinheiten wie bei einer Cranz-Schardin-Anlage gebraucht werden. Es werden einige mit einer solchen Blitzlichtanlage erzielte Ergebnisse gezeigt und kurz besprochen. Dazu gehören Photographien über Windtunnels, Stossröhren und Stosstunnels, die mit Schlieren-, Farbschlieren- und Schlieren-Interferenzmesser-Anlagen gemacht wurden.

A Review of Photographic Instrumentation for Ballistic Data Acquisition

L. E. Davidson, Engineering Laboratories, Development and Proof Services, Aberdeen Proving Ground, Md.

Ballistic data which describe the component or system performance of many kinds of weapons are regularly obtained in widely separated firing sites at Aberdeen Proving Ground. This paper describes the many applications of instrumentation photography used in weapons testing, in-including high-speed photography, shutterless slit photography, photogrammetric camera systems, tracking cinetheodolites and flash x-ray techniques.

Un compte rendu sur les instruments photographiques utilisés pour l'obtention de données balistiques

L. E. Davidson, Engineering Laboratories, Development and Proof Services, Aberdeen Proving Ground, Maryland

On recueille régulièrement des données balistiques sur le fonctionnement isolé ou d'ensemble de nombreux types d'armes à feu en des emplacements de tir très disséminés sur le Polygone d'Aberdeen. Le présent mémoire décrit les multiples applications de la photographie à instruments utilisée dans les essais d'armes, notamment la photographie à grande vitesse, la photographie à fente sans obturateur, les systèmes à caméra photogrammétrique, les cinéthéodolites de dépistage et les techniques de rayons X à flash.

Eine Übersicht über die zur Erlangung ballistischer Daten verwendeten Geräte

L. E. Davidson, Engineering Laboratories, Development and Proof Services, Aberdeen Proving Ground, Md.

Auf den weit voneinander entfernten Plätzen am Aberdeen Proving Ground werden regelmässig ballistische Daten aufgenommen, welche die Leistung eines Bestandteils oder einer Bestandteilgruppe vieler Arten von Waffen angeben. Dieser Artikel beschreibt die vielfache Anwendung photographischer Geräte, die zum Prüfen von Waffen verwendet werden, einschliesslich der Hochgeschwindigkeits-Photographie, verschlussloser Schlitzphotographie, photogrammetrischer Kameraanlagen, zielwegverfolgender Kine-Theodoliten und Blitz-Röntgenmethoden

A film lecture with examples of high-speed cinematography, presented by Werner Kraus, Leverküsen-Bayerwerk, Farbenfabriken Bayer, Germany

——— FRIDAY 8:00 P.M. SESSION: Films — Applications: Medical and Biological

Blood-cell measurement: Dr. P. A. C. Monro, Anatomy School, University of Cambridge, England; presented by A. M. P. Brookes, Dept. of Eng., University of Cambridge, England

Photographic Problems, Techniques and Instrumentation in Sea Animal Locomotion Studies

Irving Rehman, Consultant, Oceanic Research Div., Research Dept., U.S. Naval Ordnance Test Station, China Lake, Calif.

Published reports of researches and observations on sea animal locomotion indicate that many sea mammals and fish are capable of achieving high speeds at very small expenditures of energy over long periods of time with no observable drag. Since the energy requirements for these velocities are far beyond that available from the animals' muscular and vascular systems, the need for accurate data and measurements under controlled conditions of the power requirements to accelerate to maximum speed, maintain top speed, glide and decelerate, was necessary in order to determine objectively whether these inordinately great efficiencies were actually being obtained.

A porpoise was trained to perform a number of tasks on command for this research program. Hydrodynamic, physiologic and acoustic studies of this phenomenon were undertaken by NOTS and also at several associated facilities. High-speed photography (above and underwater), underwater schlieren, specular light, spark, high-powered stroboscopic and synchronized stroboscopic motion-picture photography were used. Additional techniques using neutral density beads, bubbles and dyes were also used to visualize the flow fields and boundary layer control. Extremely accurate timing data were obtained simultaneously.

Studies of the anatomic structures of the porpoise, whale and some fast-swimming fish demonstrated peculiarities that necessitated physiologic studies of vascular flow to ascertain its influence on boundary layer control and flow field. Acoustic data were also taken during the

Les problèmes, les techniques et les instruments de photographie dans les études sur la locomotion des animaux marins

Irving Rehman, Oceanic Research Div., Research Dept., U.S. Naval Ordnance Test Station, China Lake, Californie

Il ressort de rapports publiés de recherches et d'observations sur la locomotion des animaux marins que de nombreux mammifères et poissons de mer sont capables d'attendre de grandes vitesses avec de très faibles dépenses d'énergie pendant de longues périodes de temps sans qu'on puisse observer de résistance à l'avancement. Etant donné que l'énergie nécessaire pour atteindre ces vitesses dépasse considérablement les disponibilités d'énergie permises par les systèmes musculaires et vasculaires des animaux marins, on a jugé nécessaire de recueillir des données et mesures précises, dans des conditions soigneusement contrôlées, de l'énergie qu'il faut pour accélérer jusqu'à la vitesse maximum, pour maintenir cette vitesse maximum, pour glisser et pour ralentir, afin de déterminer objectivement si ces prouesses extraordinaires sont vraiment accomplies.

Aux fins de ce programme de recherches, on a entrainé un marsouin à effectuer un certain nombre de manoeuvres sur commandement. Des études hydrodynamiques, physiologiques et acoustiques de ce phénomène ont été entreprises par NOTS, ainsi que par plusieurs centres associés. On a employé la photographie à grande vitesse (en surface et sous l'eau), la photographie schlieren sous-marine, celle à lumière spéculaire et à étincelles, ainsi que la photographie stroboscopique à grande puissance et la cinématographie stroboscopique synchronisée. On a eu recours aussi à d'autres techniques utilisant des bulles, des colorants ou des sphères de densité neutre, afin de rendre visibles les zones de déplacement et le contrôle des nappes limitrophes.

Photographische Probleme, Methoden und Geräte bei der Untersuchung der Fortbewegung von Seetieren

Irving Rehman, Fachberater, Oceanic Research Div., Research Dept., U.S. Naval Ordnance Test Station, China Lake, Kalifornien.

Es wurden Berichte über Forschungen und Beobachtungen der Fortbewegungsweise von Seetieren veröffentlicht, nach denen viele Seesäugetiere und Fische in der Lage sind durch lange Zeitperioden hohe Geschwindigkeiten bei sehr geringem Energieaufwand und ohne sichtbare Behinderung zu erzielen. Der Energiebedarf für diese Geschwindigkeiten ist weit grösser als die Muskeln und Gefässsysteme der Tiere leisten können und es war daher notwendig objektiv festzustellen, ob diese übermässige Leistungsfähigkeit wirklich erzielt wurde; man musste unter kontrollierten Bedingungen genaue Daten erhalten und Messungen des Kraftbedarfs für die Beschleunigung zur Höchstgeschwindigkeit, Beibehaltung der Höchstgeschwindigkeit, Weitergleiten und Verlangsamen vornehmen.

Es wurde für dieses Forschungsprogramm ein Delphin dazu abgerichtet verschiedene Aufgaben auf Befehl durchzuführen. Sowohl bei NOTS wie bei verschiedenen anderen angeschlossenen Stellen wurden hydrodynamische, physiologische und akustische Untersuchungen des Vorgangs gemacht. Man verwendete Hochgeschwindigkeits-Photographie (auf und unter dem Wasserspiegel), Unterwasser-Schlieren, Spiegellicht, Funken, Hochenergie-Stroboskopie und synchronisierte stroboskopische Kinematographie. Weitere Methoden mit Perlen neutraler Dichte, Blasen und Farbstoffen wurden ebenfalls benützt um die Strömungsfelder und die Grenzschichtenregelung sichtbar zu machen. Gleichzeitig wurden ausserordentlich genaue Zeitmessungen gemacht. Untersuchungen des anatomischen Baues des Dalphins, des Walfisches und einiger

tions including books and technical papers, a number of these being published in the Society's *Transactions* and *Journal*. One of his better known books is *The Theory of the Photographic Process*, published in 1942 and revised in 1954. His long and distinguished professional career in the United States began in 1912 when he left England, his native country, to join Eastman Kodak Co. where he first organized a research department. He became a vice-president in 1934. He retired in 1955. An extensive Biographical Note, written on the occasion of his retirement, by Glenn E. Matthews, was published in the January 1956 *Journal* (pp. 59-60).

The son of a Wesleyan minister, Dr. Mees was born at Wellingborough, England, May 6, 1882. He studied at English schools and St. Dunstan's College. In association with Samuel E. Sheppard, he engaged in research at University College, London, where he was granted the degree of Doctor of Science in 1906.

During the following six years he was partner and joint managing director of Wratten & Wainwright, a photographic firm of Croydon, England, and in 1912 he accepted George Eastman's invitation to join the Kodak company.

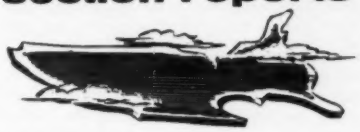
He is particularly noted for his work in the development of the infrared photographic plate which greatly advanced the use of photography in astronomical research. He was also interested in the development of practical and inexpensive equipment for amateur motion pictures and home use.

During his career Dr. Mees received numerous scientific awards. A few of the more noteworthy of these awards were the SMPTE Progress Medal, the Progress Medal of the Royal Photographic Society of Great Britain, the Medal of the Franklin Institute, the Janssen Medal of the Société Française de Photographie, the Henry Draper Medal of the National Academy of Sciences, the Progress Medal of the Photographic Society, the Rumford Medals of the American Academy of Arts and Sciences, and the Adelskold Medal of the Swedish Photographic Society.

He was an Honorary Fellow of the Royal Photographic Society, A Fellow of the Royal Society of London (the highest award to scientists of the United Kingdom), an Honorary Fellow of the Photography Society of America, an Honorary Master of Photography of the Photographers Association, and Honorary Member of the Optical Society of America, and a member of a number of other organizations.

He became a member of the Society shortly after it was founded. His paper on "Color Photography" appears in the May 1922 issue of the *SMPE Transactions*, the first of a number of significant papers published in subsequent issues.

section reports



The Rochester Section meeting report for May 19 (June 1960 *Journal*, p. 454) stated that Richard Burkhart received First Prize in the four-year student division for the paper "Development Determination by Infrared Densitometry." Co-author of the paper, who shared in the First Prize, is Conrad A. Strub whose name was inadvertently omitted from the report of the meeting.

The San Francisco Section met on August 16 at the Ampex Corp. plant in Redwood City to hear R. A. Isberg describe the S-3300B Tape Duplicator.

This recorder was designed particularly for the production of 7½- and 3¾-ips four-track stereo tapes. The master reproducer operates at either 120 or 60 ips and the slaves operate at 60 or 30 ips. This new duplicating speed is twice as fast as that of previous models of Ampex duplicators. The cost of the production of these tapes has been reduced by the savings in the amount of tape required for a given length of recording and by improvements in tape duplicating equipment. Superior quality

course of these hydrodynamic and physiologic tests. A motion picture of the test facility, equipment (timing and photographic, etc.) and some of the results obtained are shown.

On a obtenu simultanément des données de chronométrage extrêment précises.

On a mis en lumière par des études de la structure anatomique du marsouin, de la baleine et de certains poissons à nage rapide, certaines particularités de ces animaux qui ont nécessité des études physiologiques de leur circulation vasculaire dans le but de déterminer l'influence de cette dernière sur le contrôle des nappes limitrophes. On a également recueilli des données acoustiques au cours de ces essais hydrodynamiques et physiologiques. Il est présenté un film cinématographique montrant les installations utilisées pour les essais, l'équipement mis en oeuvre (photographique et de chronométrage, etc.) et une partie des résultats obtenus.

schnell schwimmender Fische zeigten Besonderheiten, welche physiologische Studien der Blutzirkulation erforderten, um deren Einfluss auf die Grenzschichtenregelung und das Strömungsfeld festzustellen. Im Lauf dieser hydrodynamischen und physiologischen Versuche wurden auch akustische Daten aufgenommen. Es wird ein Kinefilm gezeigt in dem man die Versuchsanlage, die Ausrüstung (für Zeitmessung, Photographie usw) und einige der erzielten Resultate sehen kann.

A nine-minute film: presented by D. L. Murray Thomas, associated with Dr. E. S. Gurdjian in neurological surgery, Detroit, Mich.
A film: presented by Eric Lucey, Dept. of Animal Genetics, University of Edinburgh, Scotland

9:00 P.M. Farewell Party

OCTOBER 22 — SATURDAY 9:00 A.M. SESSION: Applications — High-Speed F'ow Dynamics

A Study of the Structure and the Ultrasonic Emission of a High-Speed Air Jet With an Ultra High-Speed Electronic Camera

F. Canac and M. Merle, Centre de Recherches Scientifiques, Industrielles et Maritimes de Marseille, France

A high-speed air jet creates an ultrasonic acoustic field which can be visualized by the schlieren method. In this manner certain relations between the emitted frequency and the generating pressure can be determined. Besides, the shadowgraph method supplies, for a given pressure, two types of information according to the duration of the exposure: 1) With exposures of the order of one second one observes, by integration, a characteristic cellular structure of a pressure interval; 2) with exposures of the order of one millionth of a second one observes, at a given moment, this structure and — using an ultra high-speed electronic camera (e.g. at 10^{-6} sec.) — a periodic oscillation of the jet is shown. It is found that this period is the same as that of the emitted frequency. If each single frame of the electronic camera is repeated a number of times on a film, it is possible to project all the details of these phenomena in slow motion.

Etude de la structure et de l'émission ultrasonore d'un jet d'air à grande vitesse au moyen d'une caméra electronique ultra-rapide

F. Canac et M. Merle, Centre de Recherches Scientifiques, Industrielles et Maritimes de Marseille, France

Un jet d'air à grande vitesse crée un champ acoustique ultrasonore. La méthode des stries permet de le visualiser. On détermine ainsi certaines relations entre la fréquence émise et la pression génératrice. D'autre part, la méthode d'ombrographie donne, pour une pression donnée, deux types de renseignements suivant la durée de la pose: (1) pour des poses de l'ordre de la seconde on observe, par intégration, une structure cellulaire caractéristique d'un intervalle de pression; (2) pour des poses de l'ordre du millionième de seconde, on observe, à un instant donné, cette structure et, en utilisant une caméra électronique ultra-rapide (au 10^{-6} s par exemple) on met en évidence une oscillation périodique du jet. On constate que cette période est égale à celle de la fréquence émise. En répétant au préalable sur un film un certain nombre de fois chaque vue séparée de la caméra électronique, on peut projeter au ralenti ces phénomènes dans tous leurs détails.

Untersuchungen der Struktur und der Ultraschallwellen eines Luftstroms grosser Geschwindigkeit mittels einer Höchstgeschwindigkeits-Elektronenkamera

F. Canac und M. Merle, Centre de Recherches Scientifiques, Industrielles et Maritimes de Marseille, Frankreich

Ein Luftstrom grosser Geschwindigkeit ruft ein Feld von Ultraschallwellen hervor, das durch die Schlierenmethode vorstellbar gemacht werden kann. Auf diese Weise lassen sich gewisse Beziehungen zwischen der ausgesandten Frequenz und dem verursachenden Druck bestimmen. Anderseits gibt das Verfahren der Schattenphotographie für einen gegebenen Druck zwei verschiedene Typen von Angaben, je nachdem wie lange die Belichtungszeit ist: Bei Aufnahmen von ungefähr einer Sekunde lässt sich eine charakteristische Zellenstruktur eines Druckintervalls beobachten; bei Aufnahmen von einer Millionstel Sekunde kann man, zu einem gegebenen Moment, diese Struktur beobachten und eine periodische Oszillation des Strahls darlegen, indem man eine Elektronenkamera höchster Geschwindigkeit (z.B. von 10^{-6} s) verwendet. Man stellt fest, dass diese Periodenzahl der ausgestrahlten Frequenz gleich ist. Indem man jede einzelne Aufnahme der Elektronenkamera auf einem Film mehrfach wiederholt, kann man diese Erscheinungen in allen ihren Einzelheiten in Zeitlupenform auf den Schirm werfen.

Photographic Investigation of a Pulsating Jet Impinging on a Heated Plate

G. F. Cochrane, Jr., and R. G. Nevins, State University, Manhattan, Kansas

The purpose of this investigation was to develop a technique to obtain photographic records necessary to check the validity of approximate equations involving arbitrary assumptions which are used to describe the thickness of the thermal boundary layer formed when a pulsating air jet impinges upon a flat, heated plate.

To detect the temperature gradients, which vary with time, a multiple slit-grating schlieren apparatus was used. For recording the temperature gradients made visible by the schlieren apparatus, a high-speed motion-picture camera was used. Films were obtained which show the

L'investigation photographique d'un jet pulsatoire au point d'impact avec une plaque chauffée

G. F. Cochrane, Jr., et R. G. Nevins, State University, Manhattan, Kansas

Le but de cette investigation a été de mettre au point une technique permettant d'obtenir les enregistrements photographiques nécessaires pour vérifier la validité d'équations approximatives impliquant des hypothèses arbitraires qu'on emploie pour définir l'épaisseur de la couche-limite thermique formée quand un jet d'air pulsatoire se heurte contre une plaque chauffée à surface plane.

Pour déceler les variations de température, qui sont fonction du temps, on a utilisé un appareil schlieren avec treillis à fentes multiples. Pour l'enregistrement des variations de température

Photographische Untersuchung eines pulsierenden Strahls der auf eine heisse Platte auftrifft

G. F. Cochrane, Jr., und R. G. Nevins, State University, Manhattan, Kansas

Es war der Zweck dieser Untersuchung eine Methode zu finden, mittels welcher man die nötigen photographischen Aufzeichnungen machen kann, um die Richtigkeit ungefährer Gleichungen zu prüfen, die mit willkürlichen Annahmen gemacht wurden und die dazu dienen die Dicke der thermischen Grenzschicht zu beschreiben, die gebildet wird, wenn ein pulsierender Luftstrom auf eine flache geheizte Platte auftrifft.

Um die Temperaturgradienten zu finden, die zeitveränderlich sind, wurde ein Mehrfachschlitz-Gitterschlierenapparat benützt. Um die

stereophonic tapes may be purchased at prices that are comparable with stereophonic disks.

Also on display for our inspection was the new MX-35 four-position two-channel mixer with switching facilities for stereo and monophonic applications. A question-and-answer period followed the formal presentation by Mr. Isberg.—Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco 24.

The San Francisco Section met on July 12 at KGO-TV Studios with an attendance of 27. Guest speakers were Charles Coates, Fairchild Camera and Instrument Co., and E. Carroll Moran, Brooks Camera Store, both of whom discussed the Fairchild Cinephonic 8mm Camera and Projector.

Mr. Coates explained the operation of the camera and projector and stated that it was developed to bring to the amateur a new device which will help him to obtain more professional results. This camera is the first of its kind using 8mm prestriped magnetic track, which allows a single-system lip-sync sound recording to be made. Two films were projected using this system and sound recordings with the audience participating were made.—Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco 24.

The Washington Section met on June 11 at Colonial Williamsburg, Virginia, with an attendance of more than 40. Speakers were Loren L. Ryder, President, Magnetic Sales Corp., Hollywood, who discussed "Methods of Simplifying and Improving Synchronous Sound Handling"; Arthur L. Smith, Harry Patton, David E. Strom and John C. Goodbody, all of Colonial Williamsburg, who told of "The Use of Audio Visual in Telling the Story of Colonial Williamsburg."

The first part of the meeting included a get-together dinner at the Williamsburg Lodge, which was very successful. Following the introduction of guests, the motion picture, *History Brought to Life*, was shown. The late Cecil B. DeMille appeared in and narrated this film which was used to set the stage for the meeting. Mr. DeMille would have been proud of the results at Williamsburg which it was our privilege to observe.

Through the efforts of Norwood Simmons and James Barker we were fortunate to have Mr. Ryder with us. He supervised the location sound recording for *Williamsburg — Story of a Patriot*, and his presence was most appropriate. Earlier comments by Mr. Ryder in his article "Economic Aspects of Utilizing New Engineering Developments" (SMPTE *Journal*, February, 1956) were very interesting in view of his paper at this meeting. Mr. Ryder brought us up to date on the newer methods of sound recording and especially his new system. In his paper he described a sync generator mountable on any movie camera 8, 16 or 35mm, amateur or professional. The electric signal generated is recorded by echelon synchronizing magnetic heads recording on the outer edges of the tape in phase but in echelon. This does not interfere with the sound signal recorded on the standard position(s). This in general was understood.

The audience was impressed by the speaker's playback system and the demonstration. With the new system it is possible to use either a 16 mm or 8mm projector. The playback tape recorder is fitted with the Ryder Re-synchronizer which has the magnetic heads to play back the control frequency recorded on the track. This signal, is fed to a separate amplifier capable of delivering 60 w at 115 v_t is used to power the synchronous motor used to drive the projector. (This motor is added to the projector. The existing projector motor is used to furnish forced air to ventilate the lamphouse.) The original projector motor is disconnected. By threading tape start and film picture start marks in their respective proper places, the two machines will automatically start together since the amplified control frequency on the tape will furnish the power to the synchronous motor on the projector. By shifting the position slowly of the tape "Re-synchronizer" the projector altered during operation. Mr. Ryder continued by describing the many combinations and results which could be obtained with this equipment.

Interest was certainly generated by this discussion. Since the meeting there have been several inquiries regarding these devices.

That every one of the Colonial Williamsburg audio-visual staff had an intense pride in their work was very evident. Arthur L.

temperature gradients in the direction perpendicular to the heated plate and their variation with time.

rendues visibles par l'appareil schlieren, on a employé une ciné-caméra à grande vitesse. Les films obtenus montrent les variations de température dans un sens perpendiculaire à la plaque chauffée et leur évolution en fonction du temps.

Temperaturgradienten aufzuzeichnen, die durch den Schlierenapparat sichtbar gemacht wurden, verwendete man eine Hochgeschwindigkeits-Kinekamera. Es wurden Aufnahmen erzielt, welche die Temperaturgradienten in der senkrecht zur geheizten Platte liegenden Richtung und ihre zeitmässigen Schwankungen zeigen.

High-Speed Photography of Liquid/Solid Impact

J. H. Brunton, University of Cambridge, England

A study has been made using high-speed photographic methods of the phenomena occurring when a solid surface is struck by a small mass of liquid moving at very high speeds. An apparatus has been constructed for projecting small (1-mm diameter) cylinders of water at solid surfaces at velocities up to 1000 m/sec. The flow of the liquid mass and the break-up of the solid target on impact have been photographed, using a Beckman & Whitley rotating mirror camera (Model 189) and also a 6-spark Cranz-Schardin system. Schlieren and photoelastic techniques have been used to determine the stress distribution within the target material during impact.

By using these methods it has been possible to show that most of the deformation of the target is due to compressible behavior within the colliding liquid mass. Failure due to the shearing action of liquid flowing over the surface of the target and to the reflection and interference of stress waves in the target itself is also considered.

La photographie à grande vitesse de l'impact entre un liquide et un solide

J. H. Brunton, University of Cambridge, Angleterre

On a eu recours aux méthodes de photographie à grande vitesse pour étudier les phénomènes qui se produisent lorsqu'une surface solide est frappée par une petite masse de liquide se déplaçant à de très grandes vitesses. On a construit un appareil permettant de projeter de petits cylindres d'eau (d'un diamètre de 1 mm) contre des surfaces solides à des vitesses allant jusqu'à 1000 m/s. On a photographié le déplacement de la masse liquide, ainsi que la désagrégation de la cible solide lors de l'impact, au moyen d'une caméra à miroir tournant Beckman & Whitley (Modèle 189), et aussi d'un système Cranz-Schardin à 6 étincelles. On a utilisé les techniques schlieren et photoélastique pour déterminer la répartition des efforts et des tensions au sein de la matière de la cible au moment de l'impact.

On a réussi, au moyen de ces méthodes, à démontrer que la majeure partie de la déformation de la cible est due à un phénomène de compression au sein de la masse liquide entrant en collision. L'auteur examine aussi les cas d'échec attribuables à l'action de cisaillement de l'écoulement liquide sur la surface de la cible et à la réflexion ou interférence d'ondes de tension dans la cible proprement dite.

Hochgeschwindigkeits-Photographie des Auftreffens von Flüssigkeiten auf Festkörper

J. H. Brunton, University of Cambridge, England

Unter Anwendung von photographischen Zeitdehner-Methoden wurde eine Untersuchung der Phänomene vorgenommen, die sich abspielen, wenn eine beliebige Menge einer sich mit grosser Geschwindigkeit bewegenden Flüssigkeit auf eine feste Oberfläche auftrifft. Es wurde ein Apparat gebaut, um kleine Zylinder von Wasser (1 mm Durchmesser) mit Geschwindigkeiten bis zu 1000 m/s gegen feste Flächen zu treiben. Das Strömen der Flüssigkeitsmenge und das Zerbrechen des festen Zieles beim Aufschlag wurde photographiert, indem man eine Beckman and Whitley Rotationsspiegelkamera (Modell 189) und auch eine 6-Funken Cranz-Schardin-Anlage verwendete. Um die Beanspruchung und Spannungen zu bestimmen, die sich innerhalb des Zielmaterials beim Aufschlag verteilen, wurden Schlieren- und photoelastische Methoden angewendet.

Ihre Verwendung ermöglichte es zu zeigen, dass der grösste Teil der Deformierung des Zieles auf das kompressible Verhalten der aufschlagenden flüssigen Masse zurückzuführen ist. Es wird auch die Möglichkeit des Brechens infolge der Scherwirkung der über die Zieloberfläche strömenden Flüssigkeit und der Reflexion und Interferenz von Spannungswellen im Ziel selbst betrachtet.

Photomicrographic Device Applied to the Study of Atomization of Liquid Fuels Within a Combustion Chamber

Willy Diamant, Champigny s/Marne, France

Critical illumination is correctly obtained by means of a very luminous vertical slot of variable width through which the image of any part of the jet is obtained. A microscope carries a precisely balanced rotating mirror whose speed is variable. If the sweeping speed of the mirror is adjusted to that of the droplets moving in the field of observation, their image in the plane of the eyepiece will be immobile, and then their photography, too, will be possible. The optical elements have been carefully determined, for the lowering of contrast is caused, to a high degree, by optical aberrations. It is, on the other hand, maximum contrast which permits the best perception of the droplets.

The experimental part concerns the mechanics of the atomization. It is known that high pressures are directly related to very small droplet diameters. The research made has shown that the phenomenon of resolution of the jet takes place in a zone near the orifice of the injector and also, that from this origin on, the relative speed of the jet with reference to the air plays a fundamental role. This prime factor is localized in what is known as the "passage layer." A toric chamber is arranged around the jet. An interior channel distributes compressed air to the interior of a conical nozzle which extends from this chamber. This funnel creates a very thin layer of air which moves in opposite direction to the jet and whose apex meets the jet region near the nose of the injector. The

Dispositif photomicrographique appliqué à l'étude de la pulvérisation des combustibles liquides au sein d'une chambre de combustion

Willy Diamant, Société Nationale de Fonderie, Champigny-sur-Marne, France

L'éclairage critique est correctement réalisé au moyen d'une fente verticale très lumineuse, de largeur variable, dont on forme l'image dans une partie quelconque du jet. Un microscope — destiné à l'observation — comporte un miroir tournant très bien équilibré, et dont la vitesse est variable. Si la vitesse de balayage du miroir est ajusté à celle des gouttelettes, se déplaçant dans le champ objet, l'image de celles-ci est fixé dans le plan de l'oculaire. La photographie est alors également possible. Les éléments optiques ont été rigoureusement déterminés, car la baisse de contraste est liée, en grande partie, aux abérrations optiques. D'autre part, c'est le contraste maximum qui autorise la perception optimum des gouttelettes.

La partie expérimentale traite du mécanisme de la pulvérisation. On sait qu'à de grandes pressions correspondant des diamètres de gouttelettes très petits. Or, la recherche poursuivie a montré que le phénomène de résolution du jet intéresse une région voisine de l'orifice de l'injecteur, et que, de plus, la vitesse relative du jet par rapport à l'air joue un rôle fondamental dès cet origine. Ce facteur primordial est localisé dans ce qu'on appelle la "couche de passage." Une chambre torique a été aménagée autour du jet. Un canal intérieur distribue de l'air comprimé l'intérieur d'un ajutage conique prolongeant la chambre ci-dessus. Cet entonnoir engendre une nappe conique d'air très fine, dirigée en sens contraire du jet, et dont le sommet se confond avec la

Die Anwendung eines photomikrographischen Apparats zur Untersuchung der Zerstäubung flüssiger Brennstoffe innerhalb einer Verbrennungskammer

Willy Diamant, Champigny s/Marne, Frankreich

Man erhält die kritische Beleuchtung in richtiger Weise mittels eines sehr hellen Vertikalschlitzes verstellbarer Breite, wodurch man das Bild eines beliebigen Teiles des Strahls erzielt. Ein für die Beobachtung bestimmtes Mikroskop trägt einen sehr gut ausbalanzierten rotierenden Spiegel, dessen Geschwindigkeit variable ist. Wenn die Abtastgeschwindigkeit des Spiegels der Geschwindigkeit der Tröpfchen angepasst ist, die sich im Objektivfeld bewegen, bleibt deren Bild in der Okularebene unbeweglich, womit dann auch das photographieren möglich wird. Die optischen Elemente wurden sorgfältig bestimmt, denn die Senkung des Kontrasts ist grossenteils die Folge optischer Aberrationen. Anderseits ist es ein möglichst starker Kontrast der die beste Beobachtung der Tröpfchen ermöglicht.

Der experimentelle Teil behandelt die mechanische Form der Zerstäubung. Es ist bekannt, dass grosse Drücke sehr kleinen Durchmessern der Tröpfchen entsprechen. Nun haben die durchgeführten Untersuchungen gezeigt, dass die Erscheinung der Zerlegung des Strahls eine Zone betrifft, welche nahe der Düsenöffnung des Injektors liegt und dass weiterhin die Geschwindigkeit des Strahls in Bezug auf die der Luft von diesem Punkt aus eine grundlegende Rolle spielt. Dieser wichtige Faktor ist auf die sogenannte "Durchgangsschicht" beschränkt. Um den Strahl herum wurde eine toroidförmige Kammer angelegt. Ein innerer Kanal verteilt die komprimierte Luft auf das Innere einer konischen Düse, welche eine Verlängerung der erwähnten Kammer darstellt. Dieser Trichter erzeugt eine sehr dünne konische Luftschichte, die sich in entgegengesetzter Richtung zum Strahl bewegt und deren Spitze sich mit der Strahlzone nahe

Smith described the audio-visual program of Colonial Williamsburg and the need of an effective visitor orientation program. The result of this search was the use of a specially produced sound motion picture using the latest techniques and the Information Center which would contain the two theaters designed to show this orientation film which would, in sight and sound, reconstruct a period of history when Williamsburg was at its peak. He went on to describe the continuing changes in plans during construction of the Center to make use of the best of the many suggestions from leaders in the motion-picture and allied industries.

Mr. Strom made known to us the efforts of Williamsburg to make their films available and usable to schools, private industry, government, etc.

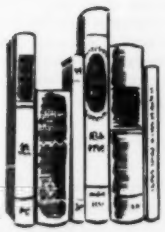
Mr. Goodbody, Vice-President, greeted us in the Information Center after we had joined a regular audience in seeing *The Patriot*. The regular audience departed and the theater was closed for the balance of the meeting. This was the first time a professional group had visited there with the primary purpose of studying the Information Center Theaters. After discussing the purposes of Colonial Williamsburg and the use there of audio-visuals, the speaker gave us some of the background material on the production of the film we had just seen. With only the SMPTE group present, Mr. Goodbody described — and because of the very interesting design of the theaters — demonstrated the many features of the auditorium while we remained in our seats.

Following this presentation, we were invited to visit what many consider the finest projection room in the world. Harry Patton and his crew of six projectionists gave a working demonstration of their ultramodern equipment — the horizontal VistaVision projectors and magnetic sound on the release print for six-channel stereophonic Todd-AO sound. We are greatly indebted to the SMPTE members at Williamsburg, not only for providing a meeting but letting us share with them the great pride they have in being a part of this art.—William W. Youngs, *Secretary-Treasurer*, 231 Mayflower Dr., McLean, Va.

SMPTE Test Films

Test films planned by the Society's technical committees and produced under the Society's exact supervision are available from the headquarters office at 55 West 42 St., New York 36. A new catalog is in preparation and will be sent upon request.

These films are used by manufacturers for testing the performance of new equipment, by television station technicians for lining up and adjusting film pickup systems, by maintenance men for "in service" maintenance of projectors and sound equipment, and by dealers for testing and demonstration equipment.



books reviewed

Lichttechnik

By Helmuth Schering. Published (1959) by Fotokinoverlag Halle, Halle (Saale), Germany. 6 by 8¼ in. 64 pp. 51 illus., 10 tables. Price DM 4.60.

This is the first in a series of German-language books under the group heading of "Kinotechnische Buecherei" to come to our attention. Each book in the series apparently covers a single, specialized portion of the motion-picture field. This particular work treats in detail of the elements between the light source and the aperture in the projector. It provides such a brief and easily understandable treatment of its subject that we now look forward with interest to the remainder of the series.

A free English translation of the compact German title might be, "The Technique of

results show that the color temperature of the flame rises with the pressure of the injected air allowing a more complete combustion. The droplets finally disappear in a zone of the flame where they normally always exist.

région du jet proche du nez de l'injecteur. Les résultats qui en découlent montrent que la température de couleur de la flamme croît avec la pression d'air injecté, ce qui autorise une combustion plus complète. Enfin, les gouttelettes disparaissent dans une région de la flamme où normalement elles existent toujours.

der Düsenspitze des Injektors mischt. Die erzielten Ergebnisse zeigen, dass die Farbentemperatur der Flamme mit der Druckerhöhung der zugeführten Luft zunimmt, was eine vollkommenere Verbrennung ermöglicht. Schliesslich verschwinden die Tröpfchen in einer Zone der Flamme, wo sie normalerweise immer vorkommen.

Photography and Analysis of Time Variation in Drop Size Distribution of a Liquid Spray

MARCUS F. HEIDMANN, Lewis Research Center, National Aeronautics and Space Administration, Cleveland

High-speed shadowgraph pictures of a finite area in the spray of two impinging water jets were taken to examine the effect of sample-size on drop-size distribution by pseudo-continuous sampling and to analyze the nature of time variations occurring in a steady-state disintegration process. The optical system included a stroboscopic light source with spark discharge of less than 1-μsec duration and a 35mm drum camera of 5-ft circumference. Continuous sampling was simulated by essentially matching spray and film velocity (500 in./sec) in 1× photographs taken 500 times/sec. A film velocity of 3000 in./sec and light flashing rate of 10,000/sec were used to study time variations. An electronic particle analyzer with electron beam scanning and digital output was used for drop counting.

A total of about 300 photographs containing nearly 35,000 drops were analyzed for these studies. Drop-size distributions were bimodal in nature and required an accumulation of at least 10,000 drops to develop fully. Random variation with major perturbations in all drop sizes occurred about 1000 times/sec or every 0.2 in. along the flow path.

Photographie et analyse des variations de temps dans la répartition des grosseurs de gouttelettes d'un brouillard de pulvérisation

MARCUS F. HEIDMANN, Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio

On a pris des photos sciographiques à grande vitesse d'une zone déterminée du brouillard produit par la collision de deux jets d'eau pour examiner l'effet de la grosseur des échantillons sur la répartition des grosseurs de gouttelettes par des prélèvements quasi-continus et pour analyser la nature des variations de temps qui se produisent dans un processus de désintègration à état stable. Le système optique employé a consisté en une source lumineuse de type stroboscopique à décharge d'étincelles d'une durée de moins de 1 μs et en une caméra-tambour de 35 mm à circonférence de 5 pieds. Le prélèvement continu d'échantillons a été simulé en synchronisant essentiellement le jet pulvérisé et la vitesse du film (500 pouces/s) de manière à obtenir des photographies sans agrandissement prises à la cadence de 500 images/s. Pour étudier les variations de temps, on a employé une vitesse de film de 3000 pouces/s et une cadence de lumière-éclair de 10.000/s. Pour le dénombrement des gouttelettes, on a utilisé un analyseur électronique de particules à exploration par faisceau d'électrons et à débit digital.

On a analysé au cours de ces études un total d'environ 300 photographies contenant près de 35.000 gouttelettes. Les répartitions des grosseurs de gouttelettes étaient de nature bimodale et ont nécessité une accumulation d'au moins 10.000 gouttelettes pour se développer complètement. Une variation irrégulière, avec perturbations marquées dans toutes les grosseurs de gouttelettes, s'est produite environ 1000 fois par seconde, soit tous les $^{2}/_{10}$ de pouce le long du parcours d'écoulement.

Photographie und Analyse der Zeitvariation bei der Verteilung der Tröpfchengrösse in einem Flüssigkeits-Zerstäubungsnebel

MARCUS F. HEIDMANN, Lewis Research Center, National Aeronautics and Space Administration, Cleveland

Es wurden Schattenzeichner-Aufnahmen einer bestimmten Zone im Zerstäubungsnebel zweier aufeinander auftreffenden Wasserstrahlen gemacht, um den Einfluss der Probengrösse auf die Verteilung der Grösse der Tröpfchen durch pseudo-kontinuierliches Probenziehen zu untersuchen und die Natur der Zeitvariationen zu analysieren, die bei einem konstanten Zerlegungsprozess vorkommen. Zur optischen Einrichtung gehörte eine stroboskopische Lichtquelle, mit einer Funkenentladung von weniger als 1 μs Sekunde Dauer und eine 35 mm Trommelkamera von 5 Fuss Umfang. Kontinuierliches Probenziehen wurde dadurch simuliert, dass die Zerstäubungs- und die Filmgeschwindigkeit (500 Zoll/s) in Einzelbildern, die 500 mal je Sekunde aufgenommen wurden, in der Hauptsache auf einander eingestimmt wurde. Zur Untersuchung von Zeitvariationen wurde eine Filmgeschwindigkeit von 3.000 Zoll/s und eine Blitzfrequenz von 10.000/s angewendet. Ein elektronischer Partikelanalysator mit Elektronenstrahl-Abtastung und Dezimal-Ausgangsleistung wurde zum Zählen der Tröpfchen verwendet.

Es wurden insgesamt ungefähr 300 Photographien, die fast 35.000 Tropfen enthielten, für diese Untersuchungen analysiert. Die Verteilungen der Tropfengrössen waren bimodaler Natur und brauchten eine Ansammlung von wenigstens 10.000 Tropfen um sich vollkommen zu entwickeln. Die Zufallsvariation mit grösseren Störungen in allen Tropfengrössen kam ungefähr 1000mal/s vor oder alle 0,2 Zoll entlang des Stromverlaufs.

High-Speed Photography of Hypersonic Phenomena by Schlieren Interferometric Method

H. OERTEL, Institut Franco-Allemand de Recherches, St.-Louis, France

Series of pictures of bow waves and boundary layers of various bodies in hypersonic flows of N_2, air or CO_2 have been taken with the help of a differential interferometer working with wollastonprisms and lenses and a 24 sparks high-speed camera. The flows have been produced in a small hypersonic shoe tube at Mach numbers between 4 and 8, at stagnation temperatures between 1000 K and 4000 K and gas densities between 3.10^{-4} and 10^{-1} of the normal density. The blowing times were between 4.10^{-6} and 8.10^{-4} sec. It has been worked with spark frequencies up to $2{,}5.10^{5}$ cps. in the same spark light-source. The separation of the pictures has been obtained on rotating film. The optical arrangement has allowed the utilization of a broad light source.

Photographie ultra-rapide de phénomènes hypersoniques par strioscopie interférentielle

H. OERTEL, Institut Franco-Allemand de Recherches, St.-Louis, France

Un interféromètre différentiel, constitué essentiellement par des biprismes de Wollaston et des lentilles, a permis de réaliser, en liaison avec une chronoloupe à 24 étincelles, des séries d'images de l'onde de tête et de la couche limite de différents corps soumis à des écoulements hypersoniques d'azote, d'air ou de gaz carbonique. Ces écoulements ont été produits dans un petit tube de choc hypersonique permettant d'atteindre des nombres de Mach de 4 a 8, des températures d'arrêt entre 1000 K et 4000 K et des densités de gaz de 3.10^{-4} à 10^{-1} de la densité normale. Les rafales avaient une durée de 4.10^{-6} à 8.10^{-4}s. Les étincelles étaient produites à la fréquence de $2{,}5.10^{5}$ Hz dans un seul éclateur. La séparation des images était obtenue sur film en rotation. Le dispositif optique à permise l'emploi d'une source lumineuse étendue.

Kurzzeitphotographie von Hyperschallvorgangen mit Hilfe des Schlieren-Interferenz-Verfahrens

H. OERTEL, Deutsch-Französisches Forschungsinstitut, St.-Louis, Frankreich

Mit Hilfe eines mit Wollastonprismen und Linsen arbeitenden Differentialinterferometers und einer 24-Funkenzeitlupe wurden Bildserien von Kopfwellen und Grenzschichten verschiedener Körper in Hyperschallstromungen von N_2, Luft oder CO_2 aufgenommen. Die Strömungen wurden in einem kleinen Hyperschallstossrohr erzeugt mit Machzahlen zwischen 4 und 8, Stautemperaturen zwischen 1000 K und 4000 K und Gasdichten zwischen 3.10^{-4} und 10^{-1} der Normaldichte. Die Blaszeiten betrugen zwischen 4.10^{-6}s und 8.10^{-4}s Es wurde mit Funkenfrequenzen bis $2{,}5.10^{5}$ Hz in derselben Beleuchtungsfunkenstrecke gearbeitet. Die Bildtrennung erfolgte auf rotierendem Film. Die optische Anordnung erlaubte die Verwendung einer Flachenlichtquelle.

Determination of the Model Behavior of Turbulence by Spark Cinematography

H. REICHENBACH, Ernst Mach Institute, Freiburg i/Br., Germany

While the expansion of shock waves in gases follows the Cranz model law very closely and thus occurs in a pseudo-stationary fashion, the

La détermination du comportement-type des turbulences par la cinématographie à étincelles

H. REICHENBACH, Institut d'Ernst Mach, Freiburg i/Br, Allemagne

Bien que l'expansion des ondes de choc dans les gaz suive de très près la loi-type de Cranz et se produise par conséquent d'une manière quasi-

Funkenkinematographische Ermittlung des Modell-Verhaltens von Wirbeln

H. REICHENBACH, Ernst Mach Institut, Freiburg i/Br, Germany

Während die Ausbreitung von Stosswellen in Gasen sehr exakt dem Cranz'schen Modellgesetz genügt und daher pseudostationär erfolgt, ist dies für die Entstehung und Ausbreitung von

Light Utilization in Motion-Picture Projectors, Principles and Practice."

Starting from a discussion of basic illumination units, methods of measurement, and reduction to common practice, the book continues with a description of condenser optics, reflector optics, and possible combinations of the two, including the "Waben" or "honeycomb cell" condenser which is relatively little known in this country. The projection lens is discussed only in terms of matching the light source optics, fuller coverage being referred to other books in the series. Light sources covered include incandescent lamps, carbon arcs, xenon arcs, and pulsed capillary arcs. Examples and tables showing relative light transmission losses of the different elements in the projection system are given: these provide a valuable basis for realistic appraisal of the light efficiency of a projector.

Slide projection is treated quite fully, as can be expected from European practice, where the still picture equipment is often closely associated with the motion-picture projector. The book concludes with examples of modern light sources in 16mm and 35mm projection systems.

Although small in size, the book contains a great amount of solid information. It should prove useful as a handbook or reference source. Illustrations are generously provided, averaging almost one per page of text, and are clear and well chosen.—*Willy Borberg*, GPL Division, General Precision, Inc., Pleasantville, N.Y.

NAB Engineering Handbook, 5th ed.

By A. Prose Walker. Published (1960) by McGraw-Hill Book Co., 330 W. 42 St., New York 36. vii-xxv + 1664 pp. incl. 1306 illus. charts, graphs, and index. 6 x 9 in. Price $27.50.

The fifth edition of the *NAB Engineering Handbook* represents a three-year undertaking to which some sixty individuals and organizations made contributions. It covers the practical aspects of AM, FM and TV broadcasting, while avoiding the type of information readily available in equipment instruction books. However, its 1664 pages and 5¼-lb weight may not comply with Webster's definition of a handbook as a "book of reference to be carried in the hand."

The book is divided into nine sections covering (a) FCC rules, regulations and standards, (b) antennas, towers and wave propagation, (c) transmitters, (d) program transmission facilities, (e) color television facilities, (f) studio facilities, (g) remote pickup facilities, (h) measurements and special techniques, and (i) charts and graphs.

The largest single section, about 25% of the Handbook, relates to FCC matters. For the most part this material is a reprint of FCC Rules, Regulations and Standards. To the extent that having the material in textbook form is a convenience, at the expense of precluding latest revisions, the presentation is useful.

The wave propagation, radiation and absorption section of the NAB Engineering Handbook, which is reprinted from Fink's *Television Engineering Handbook* (McGraw-Hill), covers the subject matter in an authoritative and concise manner. An extensive bibliography is included for the benefit of those who wish to pursue the topic in greater detail.

The section of the design, erection and maintenance of antenna structures covers the many practical problems that are of particular interest to the station owner and engineer. As is the general practice throughout the book, the text is supplemented by many clear and informative illustrations.

Antennas, antenna systems, their adjustment and measurement for AM, FM and TV, are handled individually and in very able fashion. A minimum of theory and a maximum of practical information are contained in this second largest section of the Handbook. Field intensity measurement techniques for the three services are also covered in a satisfactory manner.

As is fitting, since detailed information is readily available elsewhere, a relatively short but entirely adequate section of the Handbook is devoted to a description of typical AM, FM and TV transmitters.

Program transmission facilities for both picture and sound are dealt with at length in still another section of the *Handbook*. This material should be particularly interesting to the broadcast engineer since, as far as is known, it has only been covered in textbook form once before; and then, in much less detail.

same statement cannot be expected automatically to apply to the origin and expansion of turbulence areas as well. Various authors (e.g. Howard and Matthews) have shown through single exposures that the pseudo-stationary expansion can be assumed nevertheless to apply also to turbulence areas.

In continuation of the experimental work of H. Schardin, the expansion of turbulence on an edge in the shock-wave tube was examined with the aid of multiple-spark camera, making observations both according to principles of shadowgraph and of interference optics. These experiments showed that the expansion of the turbulence is practically pseudo-stationary — i.e., after a certain time (in our experiments about 20 μsec) has gone by, the velocity of the expansion of the turbulence becomes constant. The substantial influence of viscosity is thus limited to the very first phase of the formation of turbulence.

fixe, on ne peut pas s'attendre à ce que la même affirmation s'applique automatiquement à l'origine et à l'expansion des zones de turbulence. Divers auteurs (par exemple, Howard et Matthews) ont montré par des expositions simples que l'on peut néanmoins présumer que l'expansion quasi-fixe s'applique aussi aux zones de turbulence.

Pour compléter les travaux expérimentaux de H. Schardin, on a examiné l'expansion de turbulence sur le bord intérieur d'un tube d'ondes de choc au moyen d'une caméra à étincelles multiples, et l'on a effectué les observations suivant les principes de l'ombrographie et ceux de l'optique à interférence. Ces expériences ont démontré que l'expansion de la turbulence est pour ainsi dire quasi-fixe — c'est-à-dire qu'après qu'il s'est écoulé un certain temps (dans nos essais, environ 20 μs), la vitesse d'expansion de la turbulence devient constante. Essentiellement, l'influence de la viscosité est ainsi limitée à la toute première phase de la formation de turbulence.

Wirbelgebieten nicht ohne weiteres zu erwarten. Verschiedene Autoren (z.B. Howard und Matthews) zeigten an Einzelaufnahmen, dass trotzdem auch für Wirbelgebiete pseudostationäre Ausbreitung angenommen werden kann.

In Weiterführung experimenteller Arbeiten von H. Schardin wurde die Wirbelausbreitung an einer Schneide im Stosswellenrohr mit Hilfe einer Mehrfachfunkenkamera untersucht, wobei sowohl schatten- als auch interferenzoptisch beobachtet wurde. Diese Versuche zeigten, das die Wirbelausbreitung quasipseudo-stationär erfolgt; d.h. nach einer bestimmten Zeit — in unseren Versuchen etwa 20 μsec — stellt sich eine konstante Geschwindigkeit für die Wirbelausbreitung ein. Der wesentliche Einfluss der Zähigkeit bleibt also auf die allererste Phase der Wirbelbildung beschränkt.

SATURDAY 2:00 P.M. SESSION: Control Systems

Quenching Spark Gaps as Trigger Elements in High-Speed Motion-Analysis Cinematography

FRANK FRÜNGEL and WALTER THORWART, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Germany

Quenching spark gaps are comparatively simple and reliable devices for precision control of high-voltage pulses with great energy, particularly when operating at extremely high frequencies. Research was carried out into the parameters of pulse energy, pulsing rate, numbers and shapes of discs and filling gases. Among others, results showed, that one pair of discs can stand a load of approximately 350 v. A quenching spark gap consisting of 25 discs therefore permits triggering of voltages up to 9 kv. The controllable frequency likewise increases with the number of discs. Thus it is possible to control a 50-kc frequency with a 25-disc quenching spark gap.

When operating on the uncontrolled free-run principle, quenching spark gaps can even trigger considerably higher frequencies. A 25-disc gap thus reaches frequencies of up to 300 kc. Even at such uncontrolled discharges a precise start and stop of, say, a flashburst, can be ensured by means of heavy-duty thyratrons, one in series with the charging resistor and one short-circuiting the quenching spark gap over a delay device. Pure hydrogen or helium proved to be most suitable for filling gas and with these gases Cu-discs at a distance of 0.15–0.2 mm gave best results.

The life of the discs depends on the degree of surface cratering. However, as the quenching spark gap is demountable, one or several redressings of the electrode discs are possible. A cathode is not employed in this system, so there is no limitation of peak current, but only a thermal load limit which is computed according to specific temperature, mass of material and cooling coefficient of the filling gas. Thus the quenching spark gap has a wide field of application as a trigger element of low resistance, for high-frequency energy pulses for feeding spark discharge lamps, air sparks or pulse transformers, etc. A selection of examples will be demonstrated.

Eclateurs d'extinction comme éléments de commande en cinématographie ultra-rapide

FRANK FRÜNGEL et WALTER THORWART, Dr.-Ing. Frank Früngel GmbH, Hamburg-Rissen, Allemagne

Les éclateurs d'extinction sont des dispositifs relativement simples et surs pour la commande d'impulsions de haute tension de grande énergie, notamment si l'on travaille à des fréquences extrêmement élevées. Le but visé par la recherche était la détermination des paramètres de l'énergie et de la fréquence des impulsions, du nombre et de la forme des disques et des gaz à utiliser. Entr'autres, les résultats montrèrent qu'une paire de disques peut supporter une charge de 350 v. Par conséquent, un éclateur d'extinction composé de 25 disques peut être utilisé pour la commande de tensions jusqu'à 9 kv. La fréquence que l'on peut commander augmente également avec le nombre de disques. Ainsi, par exemple, un éclateur d'extinction comportant 25 disques permet des commander une fréquence de 50 kHz.

En fonctionnement non commandé, les éclateurs d'extinction peuvent même atteindre des fréquences notablement plus élevées. Un éclateur d'extinction à 25 disques permet d'atteindre des fréquences jusqu'à 300 kHz. Lors de telles décharges, il est mrme possible d'assurer avec précision le début et la fin d'une série d'éclairs, par exemple, à l'aide de thyratrons à grande puissance; dans ce cas, un thyratron est connecté en série avec la résistance de charge, tandis qu'un second court-circuite l'éclateur d'extinction par l'intermédiaire d'un élément retardateur. Il a été constaté que les gaz convenant le mieux pour le remplissage de l'enceinte de l'éclateur étaient l'hydrogène pur ou l'hélium. Dans ces gaz, des disques de cuivre avec intervalles de 0,15 à 0,2 mm donnèrent les meilleurs résultats.

La durée de vie des disques de cuivre dépend de l'importance des cratères se formant sur leur surface. Comme l'éclateur d'extinction est démontable, il est possible de réapproprier les électrodes en forme de disques une ou deux fois. Etant donné que l'on n'utilise pas de cathode dans ce système, il n'existe pas de limite pour le courant de crête, mais seulement pour la charge thermique; la limite de cette dernière se calcule d'après la température spécifique du matériau et le coefficient de couplage du gaz utilisé. L'éclateur d'extinction a donc un très grand champ d'application comme organe de commande de faible résistance pour des impulsions à haute fréquence et grande énergie destinées à l'alimentation de lampes à décharges, éclateurs dans l'air, transformateurs d'impulsion, etc., ce qui sera démontré à l'aide d'exemples.

Löschfunkenstrecken als Zündelemente für Hochfrequenz-Kinematographie

FRANK FRÜNGEL und WALTER THORWART, Dr.-Ing Frank Früngel GmbH, Hamburg-Rissen, Deutschland

Löschfunkenstrecken sind verhältnismässig einfache und zuverlässige Vorrichtungen für präzise Steuerung von Hochspannungs-Impulsen grosser Energie, besonders wenn bei extrem hohen Frequenzen gearbeitet wird. Die Aufgabenstellung der Forschung waren die Parameter der Impulsenergie, der Impulsfrequenz, der Anfall und Formen der Scheiben und der Füllgase. Unter anderem ergaben die Resultate, dass ein Scheiben-Paar eine Belastung von ungefähr 350 v aushalten kann. Daher kann eine Löschfunkenstrecke, die aus 25 Scheiben besteht, zum Steuern von Spannungen bis zu 9 kv eingesetzt werden. Die steuerbare Frequenz erhöht sich ebenfalls mit der Anzahl der Scheiben. So ist es z.B. möglich, eine 50 kHz-Frequenz mit einer aus 25 Scheiben bestehenden Löschfunkenstrecke zu steuern.

Bei ungesteuertem Betrieb können Löschfunkenstrecken sogar erheblich höhere Frequenzen schalten. Eine 25 Scheiben Löschfunkenstrecke erreicht so Frequenzen bis zu 300 kHz. Selbst bei solchen ungesteuerten Entladungen kann ein präziser Start und Stopp einer Blitzserie z.B. mit Hilfe von Hochleistungs-Thyratrons sichergestellt werden, wobei ein Thyratron in Serie mit dem Lade-Widerstand liegt und eins die Löschfunkenstrecke über ein Verzögerungsglied kurzschliesst. Als geeignetste Füllgase erwiesen sich reiner Wasserstoff oder Helium und mit diesen Gasen gaben Kupferscheiben bei einem Abstand von 0,15–0,2 mm die besten Resultate.

Die Lebensdauer der Scheiben hängt davon ab, in welchem Masse die Oberfläche verkratert, da die Löschfunkenstrecke jedoch demontabel ist, ist eine ein- oder zweimalige Aufarbeitung der Elektrodenscheiben möglich. Da in diesem System keine Kathode verwendet wird, besteht keine Begrenzung des Spitzenstroms, sondern nur eine thermische Belastungsgrenze, die sich nach der spezifischen Temperatur der Materialmasse und dem Kupllungs-Koeffizienten des Füllgases errechnet. Die Löschfunkenstrecke hat somit ein sehr weites Anwendungsgebiet als Schaltelement niedrigen Widerstands für hochfrequente energiereiche Impulse zur Versorgung von Funkenentladungslampen, Luftfunken oder Impuls-Transformatoren u.s.w. Eine Auswahl von Beispielen wird demonstriert werden.

The section on color television, although the second shortest in the book, covers the subject adequately. Of particular value to the practicing engineer is the chapter discussing the many factors that affect color fidelity in a television system.

The chapters on studio facilities concern themselves primarily with studio acoustics, building construction details, lighting equipment, microphone placement, magnetic recording of picture and sound, film handling, and audio and video special effects. Strangely enough, the matter of audio and video level measurements is not touched upon anywhere in the book in spite of the great importance of these widely misunderstood subjects. Neither are current, advanced methods of assembling and wiring technical facilities described in the book.

The section on remote pickup facilities includes a description of a do-it-yourself 26-mc remote pickup (audio) system, a converted commercial system for the 160-mc band, a mobile radio broadcast unit, and a detailed discussion on the handling of TV remote program originations.

A large variety of subjects is covered in the section of measurements, techniques and special applications. These include multiplex FM service, single-sideband broadcasting, UHF TV translators, remote control of standard broadcast transmitters, CONELRAD, preventative maintenance and proof of performance measurements.

A final section presenting many useful charts and tables and an extensive index complete the book.

The publisher would have been well advised to make the material available in two volumes: the first covering the FCC rules and regulations, antennas, and transmitters; the second volume covering the remaining material. Alternately the FCC material could have been omitted completely by referencing the always-current subscription service available from the U.S. Government Printing Office—*William B. Lodge*, CBS Television Network, 485 Madison Ave., New York 22.

Antitrust in the Motion Picture Industry

By Michael Conant. Published (1960) by the University of California Press, Berkeley 4, Calif.; published in England by Cambridge University Press, London. 240 pp. incl. 51 tables, bibliography, index of cases and index. 9 by 6-in. Price $5.50.

The overall purpose of the book, as set forth by the author in the Preface, is to analyze and evaluate the impact of antitrust actions on the structure, behavior and performance of an industry. The motion-picture industry, which has had more antitrust cases than any other, offered a fertile field for special spadework on the part of the author who is eminently qualified for this project. Presently Assistant Professor of Business Administration at the University of California, Berkeley, he formerly practiced law in Chicago, where he was counsel to firms in the entertainment industry.

The first of the book's nine chapters outlines the history of the motion-picture industry from the viewpoint of the economist. A great deal of the book is taken up with an exhaustive analysis of the classic Paramount case (United States v Paramount Pictures, 334 U.S. 131, 1948). Chapter III outlines the industrial structure immediately preceding the government's suit against Paramount and also traces the development of monopolistic practices from 1917 on.

Chapter V is on "The Paramount Case and Its Legal Background," and Chapter VI discusses the impact of the Paramount decrees on independent producers; the Paramount defendents, both producers and distributors; on divorced theater circuits; independent producers; and the public.

The book is heavily referenced throughout and in addition to an extensive bibliography contains an index of cases referred to (more than 150). A glance at the index gives a fleeting impression of the government's suing motion-picture organizations, both big and little; big and little organizations suing the government, and big and little organizations suing each other and individuals, and individuals suing just about everybody, all in a kind of litigous abandon. This is, of course, an erroneous impression, but it does seem that the path of the motion-picture industry has been more beset than most with legalistic tangles.

Precision Speed Control for a High-Speed Camera

DAVID A. CAHLANDER, Lincoln Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

An efficient method for regulating the speed of a high-speed motion-picture camera is described. A reluctance pickup is placed near the sprocket teeth of the drive spindle on a Fastax camera. Each time that a sprocket tooth passes the pickup, a voltage pulse is generated. The amount of time between pulses is measured and compared with the desired amount of time. An error signal is derived that controls the conduction angle for a pair of thyratrons. The thyratrons control the power into the camera motors and hence the camera speed.

This sampled data feedback loop allows one to control the picture rate of the camera with a high degree of precision. When power is applied, the camera accelerates rapidly to the preselected speed and maintains this speed until power is removed. This method is not only useful at high picture-taking rates but is also effective at speeds much lower than are normally possible with a high-speed camera. This activity has support from the U.S. Army, Navy and Air Force.

Un système de précision pour la régulation de la vitesse d'une caméra à grande vitesse

DAVID A. CAHLANDER, Lincoln Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

L'auteur décrit un procédé efficace de régulation de la vitesse d'une ciné-caméra à grande vitesse. On place un capteur de réluctance tout près des dents du pignon de l'axe d'entraînement d'une caméra Fastax. Chaque fois qu'une dent du pignon passe devant le capteur, une pulsation de voltage est engendrée. On mesure la durée de temps entre les pulsations successives et on la compare à la durée de temps désirée. On en dérive un signal d'erreur qui règle l'angle de conduction pour une paire de thyratrons. Ces thyratrons régularisent la quantité de courant à l'entrée dans les moteurs de la caméra et par suite la vitesse de la caméra.

Cette spire de rétroaction basée sur les données recueillies permet de régler la cadence de prise de vues de la caméra avec un haut degré de précision. Lorsqu'on laisse entrer le courant, la caméra s'accélère rapidement jusqu'à ce qu'elle atteigne la vitesse choisie à l'avance et maintient ensuite cette vitesse jusqu'à ce qu'on coupe le courant. Cette méthode n'est pas seulement utile aux cadences rapides de prise de vues, mais est également efficace à des vitesses beaucoup plus faibles que cela n'est normalement possible avec une caméra à grande vitesse. Cette activité a eu l'appui de l'Armée, de la Marine de Guerre et des Forces Aériennes Américaines.

Präzisions-Geschwindigkeitsregelung für eine Hochgeschwindigkeitskamera

DAVID A. CAHLANDER, Lincoln Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

Es wird eine wirksame Methode zur Geschwindigkeitsregelung einer Hochgeschwindigkeits-Kinekamera beschrieben. Ein Reluktanz-Abnehmer wird nahe den Zähnen der Antriebsspindel einer Fastax Kamera angebracht. Jedesmal wenn ein Zahn am Abnehmer vorbeigeht entsteht ein Stromimpuls. Die Zeitspanne zwischen den Impulsen wird gemessen und mit der gewünschten Zeit verglichen. Es ergibt sich ein Fehlersignal, das den Leitungswinkel für ein Paar von Thyratronen regelt. Die Thyratrone regeln den den Kameramotoren zugeführten Strom und damit die Geschwindigkeit der Kamera.

Diese Rückkopplungsschleife gemessener Daten gestattet eine sehr genaue Regelung der Aufnahmefrequenz der Kamera. Sobald der Strom eingeschaltet wird, erfolgt eine rasche Beschleunigung der Kamera bis zu der im Voraus gewählten Geschwindigkeit, die dann so lange beibehalten wird, bis man den strom abschaltet. Diese Methode ist nicht nur bei hohen Aufnahmefrequenzen nützlich sondern ist auch bei Geschwindigkeiten wirksam, die viel niedriger liegen, als bei einer Hochgeschwindigkeitskamera normaler Weise möglich ist. Diese Arbeit wird vom Heer, der Marine und den Luftstreitkräften der Vereinigten Staaten unterstützt.

Remote-Control Unit for High-Speed, Multiple Motion-Picture Cameras

FRED METLEN, Boeing Airplane Co., Seattle, Wash.

A small portable, electric remote-control unit has been designed for high-speed motion pictures for more than one camera when remote control is necessary because of the explosive or hazardous nature of the object being photographed. This remote-control unit controls the event and also is connected with other recording equipment besides the cameras. A series of slides shows the unit, wiring diagram and a few component accessories. Slides also show environments where this equipment has been used, such as explosions and wind tunnels. A short 16mm color motion picture shows the hazardous condition which prompted the planning of the remote unit. Besides the unit there are shown scenes taken by high-speed cameras.

Un dispositif de télécommande pour les ciné-caméras multiples à grande vitesse

FRED METLEN, Boeing Airplane Co., Seattle, Wash.

On a réalisé un petit dispositif portatif de télécommande électrique pour les appareils cinématographiques à grande vitesse ayant plus d'une caméra quand une commande à distance est de rigueur en raison de la nature explosive ou dangereuse de l'objet à photographier. Ce dispositif de télécommande contrôle le processus et est également relié à un autre équipement d'enregistrement en dehors des caméras. Une série de diapositifs montre l'appareil en question, le schéma de connexions et quelques-uns des accessoires correspondants. D'autres diapositifs représentent les emplacements où cet équipement a été utilisé, entre autres les chantiers à explosions et les tunnels aérodynamiques. Un film cinématographique en couleur de 16 mm et de courte longueur montre le caractère dangereux des cas qui ont conduit à la réalisation du dispositif de télécommande. Outre l'appareil lui-même, le film présente des scènes prises avec des caméras à grande vitesse.

Vorrichtung zur Fernsteuerung von Mehrfach-Kinekameras

FRED METLEN, Boeing Airplane Co., Seattle, Wash.

Es wurde eine kleine tragbare Vorrichtung entworfen, die zur Fernsteuerung von mehr als einer Hochgeschwindigkeits-Kinekamera dient, sobald wegen der explosiven oder sonst gefährlichen Natur des zu photographierenden Objekts eine Fernsteuerung notwendig ist. Diese Fernsteuerungsvorrichtung regelt das Ereignis und ist, ausser an die Kameras, auch an andere Aufnahmegeräte angeschlossen. Eine Reihe von Diapositiven zeigt die Stellen, an denen diese Vorrichtung eingesetzt wurde, wie Windtunnels und Explosionen. In einem kurzen 16 mm Farbfilm sieht man die gefährlichen Umstände, welche zur Planung der Fernsteuerung führten. Ausser dem Gerät selbst werden auch Szenen gezeigt, die mit den Hochgeschwindigkeits-Kameras aufgenommen wurden.

An Automatic Control System for a High-Speed Camera

JOHN G. G. HEMPSON, Ricardo & Co., Shoreham-by-Sea, Sussex, England

The short effective taking time of a high-speed cine camera, such as the Fastax, demands accurate synchronization of events necessary to initiate and control the phenomenon being photographed. The equipment described enables up to six events to be controlled for sequence and duration in accurate relation to the camera film run. Automatic telephone techniques and components are employed and the sequences are set up on a ring-and-socket board. A stepless accelerator is provided for the camera motors allowing high rates of acceleration in relation to stress on the film.

The case under consideration is the photography of injection and combustion phenomena in a compression ignition engine; but the equipment is flexible and can be applied to other problems and can control more events or longer periods by appropriate design modifications.

Un système de commande automatique pour une caméra à grande vitesse

JOHN G. G. HAMPSON, Ricardo & Co., Shoreham-by-Sea, Sussex, Angleterre

Le temps utile de prise de vue, de durée très courte, d'une ciné-caméra à grande vitesse telle que la Fastax exige la synchronisation précise des processus nécessaires pour déclencher et contrôler le phenomène à photographier. L'équipement décrit par l'auteur permet de régulariser l'ordre et la durée d'un maximum de six processus en relation exacte avec la vitesse du film de la caméra. On utilise des techniques et des éléments de téléphone automatique et les séries à photographier sont disposées sur un panneau à bagues et douilles. Un accélérateur non échelonné est prévu pour les moteurs de la caméra, ce qui permet de fortes valeurs d'accélération par rapport à la tension exercée sur le film.

Le cas considéré par l'auteur est la photographie des phénomènes d'injection et de combustion dans un moteur à compression et allumage. Toutefois, l'équipement en question est

Automatische Regleranlage für eine Hochgeschwindigkeitskamera

JOHN G. G. HEMPSON, Ricardo & Co., Shoreham-by-Sea, Sussex, England

Die kurze effektive Aufnahmezeit einer Hochgeschwindigkeits-Kinekamera wie Fastax macht eine genaue Synchronisierung der Vorgänge notwendig, welche die zu photographierenden Ereignisse auslösen und regeln. Das beschriebene Gerät ermöglicht es, bis zu sechs Ereignisse hinsichtlich ihrer Sequenz und Dauer in genauem Verhältnis zum ablaufenden Kamerafilm zu regeln. Es werden Methoden und Bauteile des automatischen Telephons angewendet und die Sequenzen werden auf einem Schaltbrett festgelegt. Es ist ein stufenloser Akzelerator für die Kameramotoren vorgesehen, der — im Vergleich zur Spannungsbelastung des Films — hohe Beschleunigungen zulässt. Im gegenwärtigen Fall handelt es sich um das photographieren von Injektions- und Verbrennungsphänomenen in einem Kompressionszündungsmotor; das Gerät ist jedoch vielseitig und lässt sich — mit entspre-

Fundamentals of Transistors (2d ed.)

By Leonard Krugman. Published (1958) by John F. Rider Publishers, Inc., 116 W. 14 St., New York 11. 168 pp. incl. index. Graphs and diagrams. 5½ by 8½-in. Paperbound. Price $3.50.

The first edition of this book was published in 1954 — six years after the transistor was announced by Bell Telephone Laboratories. To bring the book up to date, the 2d edition has been thoroughly revised and extended. Among other additions, advanced semiconductor devices, such as surface barriers, intrinsic, drift, avalanche and spacistor types are described in terms of theory, construction and operation. Review questions have been added at the end of each chapter and extensive reference lists are included.

The Engineering Index—1959 (75th ed.) contains more than 39,000 annotations of articles reviewed in some 1700 publications of engineering, scientific and technical societies; engineering and industrial periodicals, and publications of government bureaus, engineering experiment stations, universities and other research organizations. The Index is arranged under 249 "field of interest" Divisions of Engineering. Twelve pages are devoted to a list of technical publications received by the Engineering Index and 96 pages contain an index of authors. The volume is 7 by 10 in. and contains 1532 pages. It is published by Engineering Index, Inc., 29 W. 39 St., New York 18. It is priced at $70.

Three recent publications on educational television, all available without charge, are: *Design for ETV, Planning for Schools With Television*, Educational Facilities Laboratories, Inc., 477 Madison Ave., New York 22; *Television in Teacher Education*, The American Association of Colleges for Teacher Education, 1201 Sixteenth St., N.W., Washington 6, D.C., and *Pioneering in Educational Television*, Dept. of Electrical Engineering, State Univ. of Iowa, Iowa City, Ia. This book covers the early pioneering work in television at the University of Iowa from 1931 to 1939. The supply is limited so the books have been made available only to persons connected in some capacity with educational television.

Educational Teleguide, published by the U.S. Department of Health, Education and Welfare, is priced at 30 cents and is available from the Government Printing Office, Washington 25, D.C.

Factors affecting dropout performance in "Scotch" brand video tape No. 179 are discussed in *Video Talk*, Bulletin No. 2, available from Dept. TPC, Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. The discussion includes the effect of picture composition and of head penetration on dropouts. Also available is Bulletin No. 3 which discusses the causes of signal dropout in a video recording system and the effects of total circuit gain and demodulator performance on dropouts.

A course in Efficient Reading that began as a closed-circuit TV course for employees of one company is now broadcast over the Minneapolis-St. Paul educational television station KTCA, Channel 2. The course is viewed by employees of Minnesota Mining and Manufacturing Co., sponsors of the course, at six separate viewing locations. Eight other companies in the area have arranged for similar in-plant classes. Also, an undetermined number of home viewers throughout the area regularly "attend" the class. The course is taught by James I. Brown, Professor of Rhetoric at the University of Minnesota.

The station offers a course work sheet (without charge) and a work book priced at $3.00. More than 400 requests for both the book and the work sheet have been received by the station. The 302-page book, *Efficient Reading*, contains 66 selections of various types of literature plus instructions on scoring reading and comprehension rates, check questions on vocabulary and comprehension, etc. The book is compiled by Dr. Brown and published by D. C. Heath & Co., of Boston.

An Ampex VR-1000B Videotape Recorder is used to tape each week's course during the preceding week. Dr. Brown is present each week at one or another receiving location when the course is on the air.

An ancillary technique is also described for converting half-frame-height 16mm records to standard 16mm format and stretching, by frame repetition, of vital sequences in a film if required. Slides illustrating the equipment and a short length of film produced by it are shown.

très adaptable et peut servir à résoudre d'autres problèmes et à commander plusieurs processus ou des périodes plus longues avec les modifications appropriées de construction. L'auteur décrit aussi une technique accessoire pour transformer des enregistrements de 16mm à mi-hauteur d'image en format normal de 16mm et pour allonger s'il y a lieu, par répétition d'images, les sections essentielles d'un même film. Il est présenté des diapositifs illustrant l'équipement en question, ainsi qu'un film de courte longueur obtenu au moyen de cet équipement.

chenden Abänderungen — für andere Aufgaben und mehrere Ereignisse oder für längere Perioden verwenden. Es wird auch eine Hilfsmethode beschrieben, um 16mm Aufnahmen halber Bildhöhe auf normales 16mm Format zu bringen und um durch Bildwiederholung wichtige Sequenzen zu dehnen. Es werden Diapositive gezeigt, die die Ausrüstung illustrieren und es wird ein kurzer Film vorgeführt der damit gemacht wurde.

A Precision Control System for Ultra-High-Speed Cameras

GORDON A. GREENE and EDWARD E. GODIN, Sandia Corp., Albuquerque, N.M.

A system has been developed to provide for manual or automatic camera operation over a turbine speed range of 200 to 20,000 revolutions/sec, with an overall timing accuracy of better than 0.4%. By measuring the period of turbine rotation at frequent intervals, a direct indication of turbine velocity during camera writing time is obtained. The manual system uses a 10-mc digital counter to measure the turbine period a maximum of 175 times/sec; the counter is locked out within one counting cycle of the instant the event is recorded.

The automatic system compares every second turbine period to a preset and continuously regenerated time interval accurate to 0.1 μsec; the event is recorded when the turbine period and the time interval coincide. Time resolution of the coincidence detector is 0.05 μsec. Fundamentals of system operation and design are presented, and the original installation is described.

Un système de commande de précision pour caméras ultra-rapides

GORDON A. GREENE et EDWARD E. GODIN, Sandia Corp., Albuquerque, N.M.

On a perfectionné un système qui permet le fonctionnement manuel ou automatique de caméras sur une gamme de vitesses de turbine allant de 200 à 20.000 t/s, et cela avec une précision moyenne de réglage du temps supérieure à 0,4%. On obtient, en mesurant la période de rotation de la turbine à de fréquents intervalles, une indication directe de la vitesse de turbine pendant le temps d'enregistrement de la caméra. Le système manuel utilise un compteur digital de 10mc pour mesurer la période de turbine à une cadence maximum de 175/s; le compteur est mis hors circuit en l'espace d'un cycle de comptage après l'instant où le processus photographié est enregistré. Le système automatique compare, toutes les deux périodes, la période de la turbine avec un intervalle de temps préréglé et constamment réajusté avec une précision de 0,1 μs; le processus est enregistré quand la période de la turbine et l'intervalle de temps coincident. La résolution de temps du détecteur de coïncidence est de 0,05 μs. Les auteurs expliquent les principes de fonctionnement du système et donnent une description de l'installation initiale.

Eine Präzisionsregleranlage für Höchstgeschwindigkeitskameras

GORDON A. GREENE und EDWARD E. GODIN, Sandia Corp., Albuquerque, N.M.

Zur manuellen oder automatischen Betätigung der Kamera bei Turbinengeschwindigkeiten von 200 bis 20.000 Umdrehungen/s wurde eine Einrichtung mit einer durchschnittlichen Einstellgenauigkeit von weniger als 0,4% entwickelt. Durch häufiges Messen der Turbinenrotation erhält man direkte Angaben der Turbinengeschwindigkeit während der Aufnahmezeit der Kamera. Beim manuellen System wird die Periodenzahl der Turbine mittels eines 10 mc elektronischen Digitalzählwerks maximal 175-mal/s gemessen; sobald das Ereignis aufgenommen ist, wird das Zählwerk momentan — innerhalb eines Zählzyklus — abgestellt.

Die automatische Vorrichtung vergleicht jede zweite Turbinenperiode mit einem Zeitabstand, der im Voraus eingestellt und kontinuierlich regeneriert wird und auf 0,1 Mikrosekunde genau ist; die Aufnahme erfolgt, wenn Turbinenperiode und Zeitabstand zusammenfallen. Die Zeitauflösung des Koinzidenzfinders ist 0,05 Mikrosekunde. Es werden die Grundlagen des Betriebs und des Baues der Apparate dargelegt und es wird die ursprüngliche Einrichtung beschrieben.

Pulse Program Generator

JAKOB H. HOHL and ROLF F. MÜNGER, International Business Machines Corp. Research Laboratory, Zurich, Switzerland

For triggering a high-power, short-duration flash equipment, a pulse program generator has been developed. The instrument generates groups of 110 pulses with equal intervals. To form the pulse program, up to 30 pulses of the group may be arbitrarily chosen. The interval between two successive pulses can be varied continuously from 10 μsec to 1 sec. The generator can be started manually or by an external trigger, upon which the program runs off either once or repetitively. The instrument is fully transistorized.

Un générateur à programme d'impulsions

JAKOB H. HOHL et R. MÜNGER, Laboratoire de Recherches, IBM Corp., Zürich, Suisse

Pour obtenir la sincronisation d'un éclair électronique à grande puissance il a été développé un générateur à programme d'impulsions. Le générateur produit des séries de 110 impulsions à intervalles égaux. De ces impulsions 30 peuvent être déterminés arbitrairement pour former un cycle du programme. L'on peut varier l'intervalle entre deux impulsions successives de 10 μs à 1 s. Le démarrage d'un seul ou de plusieurs cycles du programme se fait à la main ou par un signal extérieur. L'instrument entier est muni de transistors et non pas de tubes à vide.

Impulsprogramm-Generator

JAKOB H. HOHL and ROLF F. MÜNGER, International Business Machines Corp. Research Laboratory, Zürich, Schweiz

Als Triggerquelle für ein Gerät zur Erzeugung von Kurzzeit-Lichtimpulsen hoher Leistung wurde ein Impulsprogramm-Generator entwickelt. Dieser erzeugt Serien von 110 Impulsen mit unter sich gleichen Abständen. Bis zu 30 von den 110 Impulsen können beliebig ausgewählt werden und bilden das Impulsprogramm. Der Abstand zwischen zwei Impulsen ist kontinuierlich variierbar von 10 μs bis 1 s. Der Generator kann manuell oder durch einen externen Triggerimpuls gestartet werden, worauf das Programm entweder einmal oder repetitiv durchläuft. Das Gerät ist mit Transistoren bestückt und enthält keine Röhren.

Trigger Unit for High-Speed Camera

C. P. JOHNSON and S. A. LOTT, Defence Standards Laboratories, Victoria, Australia

The trigger unit produces a spark image near the edge of the film to indicate the instant of occurrence of an external event. A thyratron is fired by interruption of a light beam falling on a nonmicrophonic photocell through a shutter which can be opened at any convenient time prior to the event. With small modifications the unit can be used to fire wire-filled expendable flashbulbs.

(*To be presented by abstract only.*)

Un dispositif déclencheur pour caméra à grande vitesse

C. P. JOHNSON et S. A. LOTT, Defence Standards Laboratories, Victoria, Australie

Le dispositif déclencheur dont il s'agit produit une image-étincelle près du bord du film pour indiquer l'instant où se produit un processus extérieur. Un thyratron est déclenché par l'interruption d'un faisceau lumineux tombant sur une cellule photo-électrique de type non microphonique par l'entremise d'un obturateur qu'on peut ouvrir à tout moment approprié avant l'arrivée du processus. Moyennant de légères modifications, le dispositif peut être utilisé pour déclencher des lampes-éclair à charge de fils ne servant qu'une fois.

Auslöser für Hochgeschwindigkeitskamera

C. P. JOHNSON und S. A. LOTT, Defence Standards Laboratories, Victoria, Australien

Die Auslösevorrichtung ruft ein Funkenbild nahe der Kante des Films hervor, um den Moment zu bezeichnen, in dem sich ein äusseres Ereignis abspielt. Ein Thyratron wird dadurch zum Aufflammen gebracht, dass ein Lichtstrahl unterbrochen wird, der durch einen Verschluss auf eine nichtmikrophonische Photozelle fällt; der Verschluss kann vor dem Ereignis zu jeder passenden Zeit geöffnet werden. Mit kleinen Änderungen lässt sich der Apparat zum Zünden der drahtgefüllten Einmal-Blitzbirnen verwenden.

END *FIN* *ENDE*

current literature

The Editors present for convenient reference a list of articles dealing with subjects cognate to motion-picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

American Cinematographer vol. 41, May 1960

The Space age—New Challenge for Cinematography (p. 288) *J. Mermoud*

Ryder Sync Motor Drive (p. 293) *J. V. Mascelli*

Progress Reports on Film (p. 296) *E. J. Townell and L. A. Shaffer*

Panavision's Progress (p. 302) *D. Scot*

Some Aspects of Cinematography for Color TV Films (p. 306) *S. P. Solow*

vol. 41, June 1960

The Development of Follow-Focus in Cinematography (p. 346)

Shooting 16mm Plus-X at 1000 ASA (p. 356) *G. C. Fenyon*

Mitchell Introduces New 35mm Reflex Camera (p. 360) *J. V. Mascelli*

Tracking Music for TV Films (p. 362) *L. W. Gordon*

Optical Effects for TV Films and Commercials (p. 366) *M. Levy*

Single-System Film Production (p. 368) *J. Bohmer*

A Synchronous Quarter-inch Tape System for Film Sound Recording (p. 370) *G. M. Galloway*

vol. 41, July 1960

New, Fast Color Films Meet Jet-Age Needs (p. 416) *N. Simmons*

Extension Tubes in Cinematography (p. 424) *J Henry*

BBC Engineering Division Monograph No. 29, Apr. 1960

A Summary of the Present Position of Stereophonic Broadcasting (28 pp.) *D. E. L. Shorter and G. J. Phillips*

Bolex Reporter vol. 10, No. 3, 1960

Underwater Movies Expand Scope of the Scuba Set (p. 14) *B. McNeely*

British Kinematography vol. 36, March 1960

"Smell-O-Vision" (p. 60)

Commercial Television: British versus Transatlantic Methods of Presentation (p. 65)

The New Colortran Lighting Units (p. 73) *P. Cavazzuti*

International Photographer vol. 32, May 1960

Schott Rare Earth Glass Reason for High Quality of West German Lenses (p. 98)

Videotape in Commercials (p. 99) *R. L. Laurence*

Sound From Kodak (p. 101)

The Cinephonic Eight (p. 104) *G. J. Toscas*

vol. 32, June 1960

Ampex Introduces Four New Developments (p. 120)

Thorium Glass Radiation Insignificant Except Under Two Conditions, Test Show (p. 123) *H. Klarmann*

Bolex Sonorizer Puts Sound on Film (p. 129)

International Projectionist vol. 35, April 1960

Large-Area Frames and Picture Quality. Part 2 (p. 5) *R. A. Mitchell*

vol. 35, May 1960

Non-Intermittent Projector Operating Principles Detailed; New Development Introduced (p. 5) *J. G. Jackson*

General Electric's Thermoplastic Recorder (p. 14)

vol. 35, June 1960

Curved Film Gates (p. 5) *R. A. Mitchell*

Jour. Brit. IRE vol. 20, Mar. 1960

Recommended Method of Expressing Electronic Measuring Instrument Characteristics: Pt. 3. Low Frequency Generators (p. 197) based on report by *M. B. Martin*

Jour. Inst. Telecommunication Engineers (New Delhi) vol. 6, Dec. 1959

Astigmatism in Cathode Ray Tubes (p. 31) *N. Patla*

Effects of Obstacles and Reflections on the Propagation of VHF Television Signals (p. 47) *B. Chatterjee*

Nomogram for Determination of Audio Power in Indoor Public Address System (p. 51) *N. K. D. Choudhury*

Journal of the Television Society vol. 9, Jan.-Mar. 1960

Television Film Production (p. 167) *J. K. Byers*

A Medium Screen Colour Projector (p. 176) *T. M. C. Lance*

Deflection Techniques for 110 Picture Tubes (p. 185) *B. Eastwood*

Kino-Technik vol. 14, Apr. 1960

Probleme des deutschen Industriefilms (p. 99) *F. Mörtzsch*

Goniometeruntersuchungen an Stereo-Tonträgern und-Geräten (p. 101) *K. O. Bäder*

Lautsprecher mit erhöhtem Präsenzgrad (p. 105) *H. Harz*

Klebetechnik in Atelier- und Kopierwerk (p. 111) *W. v. Bohnhorst*

Moderne Kino- und Photo-Objektive (p. 114) *H. Naumann*

(*Concluded on page 687.*)

Exhibit Directory

Animation Equipment Corp. Booth **65**
38 Hudson St., New Rochelle, N.Y.

Exhibiting: New electronic-controlled compound. Features extreme, continuous accuracy achieved by joystick control of the directional movement of the compound.

Personnel: Ed Willette, Gregory Bell.

Ansco Division, General Aniline & Film Corp. Booths **59, 60**
Vestal Parkway East, Binghamton, N. Y.

Exhibiting: Military cameras and rapid process equipment; industrial camera; 16mm suitcase type rapid processor; Ansco Automatic Recording Microdensitometer. Equipment, in so far as practicable, will be demonstrated.

Personnel: A. L. Derr, H. Kirby, Arthur Nields, E. G. Stamboulian, C. W. Seager.

Arriflex Corp. of America Booths **1, 2**
257 Park Ave. South, New York 10
7303 Melrose Ave., Los Angeles 46

Exhibiting: Arriflex 16 with buckle switch and buckle switch over-ride, signal generator and automatic slate; new Arriflex 35 special high-speed model; Arriflex 35 model II BV with variable shutter; varifocal lenses, 140mm Angenieux for Arriflex 35 and Arriflex 16, 85 Pan Cinor for Arriflex 16; Auxiliary Target Finder; nickel cadmium batteries, models for both Arriflex 16 and Arriflex 35, hermetically sealed new improved cells, built-in Mini Charger. The 17.5 to 70mm Angenieux in Arriflex mount will be shown with a new motor-driven zoom movement.

Personnel: Erich Kestner (Arnold & Richter), Paul Klingenstein, Victor James.

Equipment Papers and Demonstrations

Wednesday morning, October 19, from 9:30 to 12:00, exhibitors will present the following equipment papers and demonstrations. A complete list will be published in the 5th Congress Program

Beckman & Whitley, Inc.: Model 339 Continuous Writing Streak Camera.

Benson-Lehner, Inc.: Puppet Timing System and Ultra-High-Speed Framing Camera.

Camera Equipment Co.: Waddell High-Speed Camera, Weinberg-Watson Model B 16mm Projector and CECO Red Lake Stop-Motion 35mm Projector.

Eastman Kodak Co.: New Color Films for High-Speed Motion-Picture Photography.

Florman & Babb, Inc.: Acmade Mark II Editor.

L-W Photo Products, Inc.: L-W Industrialist 16mm Stop-Motion Instrumentation Projector.

Prestoseal Mfg. Corp.: 16–35–70mm Butt-Weld Splicer for intermixed material.

Traid Corp.: Traid 180° Lens for 35mm Cameras and Photo-Sonics 16mm High-Speed Prism Camera.

Carl Zeiss, Inc.: Zeiss Interferometer.

Avco Corp., Research & Advanced Development Div. Booth **41**
201 Lowell St., Wilmington, Mass.

Exhibiting: Rotating Mirror Camera (writing rate: 3.9mm/μsec); Rotating Drum Camera (writing rate: 0.19mm/μsec); Kerr Cell Shutter (exposure times from 0.005 to 0.1 μsec); Shadowgraph Photograph System to photograph projectiles moving in the 14,000 ft/sec range, and high-intensity spark light sources.

Personnel: Richard J. Burns, Bernard Slavin.

Beckman & Whitley, Inc. Booths **29, 30**
973 San Carlos Ave., San Carlos, Calif.

Exhibiting: Ultra-High-Speed Framing and Streak Cameras covering the range in framing rates from 200 to 4.3 million pictures/sec and covering the range in streak rates from 60 in./sec to one million in./sec.

Personnel: Robert D. Shoberg, Jack Patterson, Frank Provost.

Bell & Howell Co. Booths **7, 8**
7100 McCormick Rd., Chicago 45, Ill.

Benson-Lehner Corp. Booths **55, 56, 57**
11930 W. Olympic Blvd., Los Angeles 64

Exhibiting: HS 16, a 16mm instrument with intermittent movement, speed to 400 frames/sec, designed to withstand severe environmental conditions; HS 35, instrumentation camera, intermittent motion, register pin movement, 300 frames/sec; HS 70, 70mm instrumentation camera, intermittent movement, gear shift speeds to 80 pin registered frames/sec; UHS 35, Ellis Ultra-High-Speed Framing Camera, 500 frames/sec to 1.6 million frames/sec, total frames to 960, electronically controlled kerr cell shutter; Puppet, timing and correlation system for instrumentation cameras.

Personnel: Dave Webster, Len Reed, Guy Hearon, Robert Saunders.

Camera Equipment Co. Booth **42**
315 West 43 St., New York 36
1335 East 10 Ave., Hialeah, Fla.

Exhibiting: Waddell High-Speed Camera, disc shutter governor-controlled model and double and single-motor models; Weinberg-Watson Model

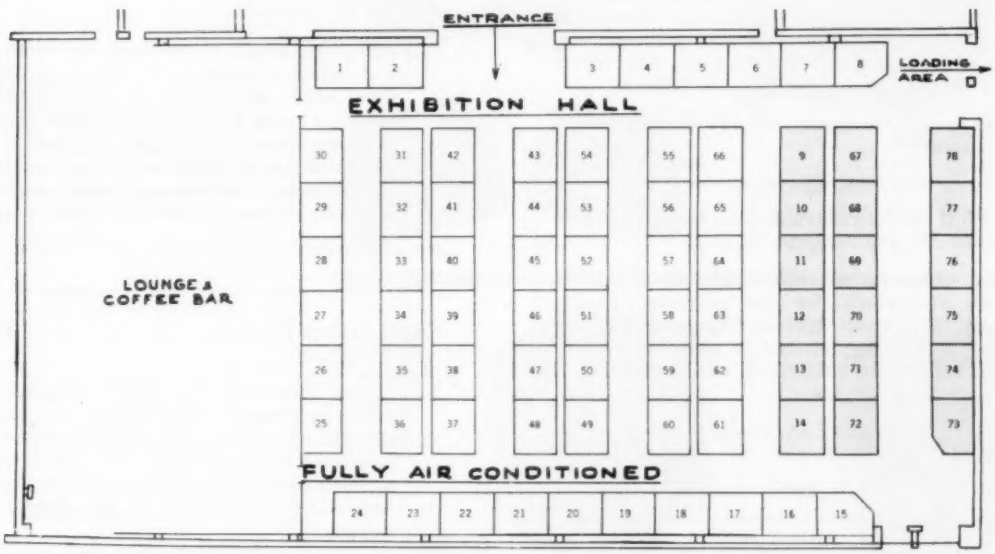
Exhibit

INTERNATIONAL CONGRESS 5TH 1960 SMPTE ON HIGH-SPEED PHOTOGRAPHY

Fifth International Congress on High-Speed Photography

Displays and demonstrations of instrumentation and high-speed photographic equipment from manufacturers all over the world. See the newest developments in specialized electronic, optical and mechanical photographic instrumentation devices for all applications.

Government and Industry Exhibits will be featured.



FOR RESERVATIONS

contact the Exhibit Chairman:
Keith B. Lewis, Eastman Kodak Co.,
1000 Connecticut Ave., N.W.
Suite 1101, Washington 6, D.C.

EXHIBIT SPACE RENTAL RATES

Booths 1-2-3-4-30-31-42-43-54-55	$350
Booths 15 to 19 incl. and 61 to 66 incl.	250
All other booths	300

Booths 9 to 14 and 67 to 78 inclusive are being reserved for military and institutional exhibits.

All booths are 8 x 10 ft in size.

October 17–21, 1960

SHERATON-PARK HOTEL, WASHINGTON, D.C.

B 16mm Projector; CECO Red Lake Stop-Motion 35mm Projector; CECO accessories for high-speed and normal photography.

Personnel: Frank C. Zucker, Burton N. Zucker, John H. Waddell, Eugene H. Levy, Allen Green.

Canadian Applied Research Ltd. Booth **47**
750 Lawrence Ave., W., Toronto 19, Ont., Canada

Exhibiting: The CARL Automatic Tri-Film Processor. Transportable processor develops and dries black-and-white negative or positive film at speeds up to 6 ft/min; 400-ft magazine; accommodates 4 16mm films simultaneously, 2 35mm or 1 70mm film; processes lengths 10 ft to 400 ft.

Personnel: W. V. O'Leary.

Computer Measurements Co. Booths **15, 16, 17**
12970 Bradley, Sylmar, Calif.

Exhibiting: Automatic cleaner for 70mm instrumentation film; automatic 70mm film splicer for continuous processing; Printer Robot, programming tape-operated system for Bell & Howell continuous printers; keyboard-perforator for preparing tapes for automatic printer operation; automatic light-intensity controller for step printers; air-vacuum squeegee kit for film printers; color timer for improved printing color balance.

Personnel: J. L. Cassingham, George W. Greenville, T. Connors.

E. I. du Pont de Nemours & Co., Inc. Booth **48**
1007 Market St., Wilmington 98, Del.

Exhibiting: High-speed CRONAR*-based (*Du Pont's trademark for its polyester photographic film base) motion-picture films. The films will be demonstrated to show the dimensional stability of CRONAR when subjected to extreme temperatures.

Personnel: F. Gerretson, D. Peak, R. Perrine, T. Harding, W. Lockwood, P. Porter, Jr., J. Vokoun.

Eastman Kodak Co. Booths **33, 34**
Rochester, N.Y.

Edgerton, Germeshausen & Grier, Inc. Booth **21**
160 Brookline Ave., Boston 15

Exhibiting: Mark VI Sensitometer; No. 501 Stroboscope; No. 2307 Double Flash Light Source for silhouette photography; Microscope Illuminator for macro- and microphotography; Type 2208 Rapatronic Camera; underwater photographic equipment, oceanographic cameras, light sources, sonar pingers which can be used for underwater photography up to the ultimate depth of 37,500 ft; XLS-10 Multiflash Unit; XLS-1 Electronic Flash Unit for night aerial photography; Micro Flash Unit for stopping motion of rapidly moving objects.

Personnel: M. D. Altfillisch, B. F. Roberts, C. W. Wyckoff, J. Treadwell, S. O. Raymond, H. E. Edgerton, A. C. Johnson.

Fairchild Camera & Instrument Corp. Booth **66**
580 Midland Ave., Yonkers, N.Y.

Exhibiting: Fairchild HS-401, 400-ft model, range of 10 to 8000 frames/sec; HS-100 Airborne Model, range of 32 to 2400 frames/sec; HS-101, range of 32 to 8000 frames/sec; HS-1101 Lens Kit; HS-2551 Tripod; Camera and Event Synchronizer; HS-401-C1 motor kit; HS-10500 Timing Light Generator; HS-5101B Full Wave Rectified Power Unit; HS-5004B Rechargeable Battery Pack; motors for high-speed cameras.

Personnel: Gerard J. Morio, Peter N. Payne, Herbert M. Oshan.

Field Emission Corp. Booth **22**
210 N. Ford St., McMinnville, Oregon

Filmline Corp. Booth **35**
43 Erna St., Milford, Conn.

Exhibiting: Model RT-S Processor for 16mm reversal and negative/positive film, dry to dry in 1 min, wash tank after each chemical solution, film squeegee on each tank, temperature control system, stainless steel Type 316 tanks, 1200-ft magazine for daylight operation, variable speed transmission, tachometer, new impingement-type film drying cabinet and related equipment.

Personnel: Edward B. Krause, John Jiruska.

Oscar Fisher Co. Booth **58**
Newburgh, N.Y.

Exhibiting: Autotrac Processall—no-thread automatic processing machine for motion-picture, roll and sheet film and paper photographic materials up to 12-in. width and 1000-ft length, at operating speeds of 50 ft/min for motion-picture film and 9 ft/min for roll and sheet films and papers.

Personnel: Oscar Fisher, Stephen Fisher, Milton Kinsler.

Flight Research, Inc. Booths **39, 40**
P.O. Box 1F, Richmond 1, Va.

Exhibiting: MULTIDATA cameras: 16mm Model III Series; 35mm Model IV Series and 70mm Model V Series; New Model VI-4 AUTEX, automatic exposure control; Model A-32 Series Intervalometer; Model 122 STROBEX Electronic Flash Unit; 35mm AUTOMAX Series Data Recording Camera; PROTECT-A-PRINT; Model A-50 Pulse Time Synchronizer.

Personnel: Wm. T. Curdts, III, John C. Pennock, Donald Bass, William K. Glave.

Kino-Technik vol. 14, May 1960

Hochfrequenzkinematographie mit Fastax-Zeitdehnerkameras im Millesekunden-Bereich (p. 137) *F. Kolb*

Die Impulslampe SPP 800 W in der Kinoprojektion (p. 141) *R. Doeckel*

Neue Kopier- und Entwicklungsmaschinen für 8-mm-Film (p. 147)

Proc. Inst. Electrical Engineers vol. 107 Pt. B No. 32, Mar. 1960

High-Power Transmitting Valves With Thoriated Filaments for Use in Broadcasting (p. 172) *H. S. Walker, W. H. Aldous, R. G. Roach, J. B. Webb and F. D. Goodchild*

RCA Review vol. 21, Mar. 1960

Simultaneous Signal Separation in the Tricolor Vidicon (p. 8) *H. Borkan*

Ringing in Horizontal-Deflection and High-Voltage Television Circuits (p. 17) *T. Murakami*

The Influence of Magnetic Tape on the Field of a Recording Head (p. 45) *D. Della Torre*

Theoretical and Experimental Study of Wide-Band Paraboloid Antenna With Central-Reflector Feed (p. 94) *P. Foldes and S. G. Komlos*

Measurement of Semiconductor Properties Through Microwave Absorption (p. 124) *R. D. Larrabee*

Research Film vol. 3, No. 5, 1960

Time-Lapse Cinematography With the Interference Microscope (p. 267) *G. G. Rose*

Filming Light-Emitting Particles in Motion (Metal Drops in Vacuum Steel-casting) (p. 297) *D. Elle*

Abstracts

Abstracts from other Journals, chosen for importance and timeliness, are published in the *Journal* from time to time. The greater number of these abstracts are translations, chiefly from the U.S.S.R., and made available by the *Kodak Monthly Abstract Bulletin*.

These subject areas are grouped below:
Cameras and Equipment
Film and Its Properties
Color Photography and Color Development
Film Processing (Apparatus and Chemistry)
Printing and Optics
Sensitometry and Image Structure
Projection

CAMERAS AND EQUIPMENT (except High-Speed)

Camera Shutter With a System of Complete Internal Reflection

The action of the patented shutter is based on the complete internal reflection of the light rays. The shutter consists of two 90-degree, glass prisms, joined together along the hypotenuse faces, between which a small interval is left. In the latter is a transparent film. The space between the film and one of the prisms is filled with a transparent liquid, the pressure of which can be controlled. On increasing the pressure, the film is pressed against the hypotenuse face of the second prism, and both prisms form a transparent cube, transmitting the light rays. On lowering the pressure, the film comes away from the second prism, and the light rays cannot pass through the cube, since they experience complete internal reflection at the hypotenuse face. S. C. G.—[Translated from *Refrerativnyi Zhur., Fiz.*] Japanese 7872. B. Takao. Filed Sept. 11, 1956.

For the Future Development of the Material and Technological Basis of Cinematography

At present the projected extension of the motion-picture network in the Soviet Union is hampered by insufficient output of apparatus and motion-picture film of the required quality. Plans for the next two or three years envisage the reconstruction of a number of apparatus factories in order to provide a sufficient number of projectors for the new cinemas, and also an increase in the number of processing laboratories, together with the improvement of those already in existence. Similar reconstructions and extensions are planned for the manufacture of motion-picture film, particularly color stock, and, if the plans for the manufacture of nonflamable base are fulfilled by 1962, the transition to safety base should be practically complete. A feature of the plans is the development of the industry in provincial centers. (S. C. G.) —*Tekh. Kino i Televideniya, 4*:1-4, Jan., 1960, (in Russian).

Motion-Picture Apparatus Factories in 1960. (I) Moscow "Kinap." (II) Odessa "Kinap." (III) Samarkand "Kinap"

Descriptions are given of apparatus being made by the three main Soviet

Florman & Babb, Inc. Booth **62**
68 West 45th St., New York 36

Exhibiting: Acmade Mark II Film Editor; Aiglonne "America" 16 and 35mm Film Processor; F&B Triplex Animation Stand; New F&B 16 and 35mm motorized film viewers; F&B nickel cadmium batteries and power supplies; Miller fluid drive heads; telescopic tracking camera viewfinder; new F&B magnetic film splicer; other new items.

Personnel: Arthur Florman, Charles Lipow, Leonard Hollander, Ted Viilu, John Babb, Don Notto.

Dr.-Ing. Frank Früngel GmbH Booth **27**
Hamburg-Rissen, Germany

Exhibiting: The Strobokin—a high-speed pulsed light capable of up to 50,000 flashes/sec; duration of each flash 1 μsec; by addition of auxiliary power pack frequency may be extended to 300,000 flashes/sec, random burst. Also—Kerr-cell type shutter and pulsed x-ray device.

Personnel: Dr.-Ing. Frank Früngel, Dr. Walter Thorwart, H. G. Patzke, Otto Dietrich, Frank Kelly (J. A. Maurer, Inc.).

Heico, Inc. Booths **37, 38**
25-27 North 6 St., Stroudsburg, Pa.

Exhibiting: Heico Resinator Mark IV. Purifies water physically and chemically through the use of Heico resins, removing such contaminants as iron, copper, algae, bacteria and sediment.

Personnel: W. J. Kellow, Jr., H. E. Ingraham, T. E. Ingraham, John H. Davis.

Karl Heitz, Inc. Booth **49**
480 Lexington Ave., New York 17

Exhibiting: Kinoptik series of more than 20 high-speed color matched Apochromats in mounts for 16mm, 35mm and TV cameras, ranging from extreme wide angle (1.9mm $f/1.9$) to telephoto (500mm $f/5.6$); Alpa 35mm all-in-one single lens reflex camera with automatic lenses, including 4 Apochromats; Robot 35mm automatic cameras with electro-magnetic photo-recording system; Sinar interchangeable view camera; Lindia snap-in mounts; Camex 8mm single lens reflex camera.

Personnel: Karl Heitz, Rick Hershberger, Yvonne Brandes.

Hi-Speed Equipment, Inc. Booth **4**
73 Pond St., Waltham, Mass.

Exhibiting: Hi-Speed Model FA-50 Spray Processor. This machine requires only two gallons of solution and processes 16/35 perforated or unperforated film at speeds up to 50 ft/min.

Personnel: Nicholas Cedrone, Richard Reedy.

Philip A. Hunt Co. Booth **36**
Palisades Park, N. J.

Exhibiting: Photographic chemicals of black-and-white and color processing. Demonstration of electrostatic prints in black-and-white and color made with Hunt toning powders.

Personnel: Charles LoBalbo, Charles Belmont, R. A. Root.

Kenyon Products, Inc. Booth **53**
Chester Airport, Deep River, Conn.

Exhibiting: Kenyon Stabilizer gyroscopic device, small, lightweight (24 oz.), used to stabilize hand-held cameras (and other optical instruments) against vibrations of aircraft, boats and land vehicles. Attached to camera by tripod mounting.

Personnel: T. W. Kenyon, E. H. Pallme, H. D. Riley, E. J. Conlin, Jr., J. H. McElroy, J. Newberry.

L. W. Photo Products Co. Booth **19**
P.O. Box 147, 18220 Parthenia St.,
Northridge, Calif.

Exhibiting: Instrumentation cameras, projectors and accessories.

Personnel: Robert H. Lawrence.

D. B. Milliken Co. Booth **28**
131 N. Fifth Ave., Arcadia, Calif.

Exhibiting: Milliken 16mm High-Speed Motion-Picture Cameras; speeds from 4 to 400 frames/sec.; intermittent movement with register pin: DBM 3–100 ft, DBM 4–200 ft, DBM 5–400 ft, DBM 9–400 ft (waterproof).

Personnel: Donald B. Milliken, T. W. Truesdell, R. L. Rodgers.

Motion Picture Enterprises, Inc. Booth **44**
Tarrytown, N.Y.

Exhibiting: Film reels, cans and shipping cases; video tape reels; professional editing and laboratory equipment; Marguet splicers; Motion Picture and TV Service Directory.

Personnel: Herbert R. Pilzer, Victor Thomas.

Neumade Products Corp. Booth **43**
250 W. 57 St., New York 19

Exhibiting: Video tape cabinets; audio tape cabinets; 70mm, 35mm and 16mm film cabinets; synchronizers, splicers and rewinds for 16mm, 35mm and 70mm; filmstrip and slide storage; film cleaner; editing tables.

Personnel: Lee E. Jones, Lew Grofsik, Robert E. Hempel, Warren W. Clements.

Nissei Sangyo Co., Ltd. Booth **18**
501 Fifth Ave., New York 17

Exhibiting: High-speed camera with specifications of 16H camera body, camera speed 500 to 10,000 frames/sec., standard lens, single reflex type; timing light pulse generator, 100 to 1000 pulses, lens kit and accessories; Mitchell type tripod.

Personnel: K. Okamoto

O'Connor Engineering Laboratories Booth **63**
9862 Highland Ave., Alta Loma, Calif.

Exhibiting: O'Connor Engineering Fluid Pan and Tilt Heads. Model C carries 20 lb; Model 100, 100 lb; Model 200A, 200 lb-suitable for TV; Model 200X, 150 lb-designed for missile tracking.

Personnel: J. T. Brodie, C. O'Connor.

Photo-Sonics, Inc. Booth **54**
820 South Mariposa St., Burbank, Calif.

Exhibiting: 70mm Full-Frame (2.25 in. × 2.25 in.) Camera—180–360 frames/sec; 70mm Full-Frame Camera, high-speed intermittent—10 to 80 frames/sec; 70mm Ballistic Synchro Camera; 35mm High-Speed Rotary Prism Camera; 16mm High-Speed Rotary Prism Camera (3 models); 16mm Thin Line, Underwater High-Speed Camera.

Personnel: John Kiel, Darrell Lassiter.

Photo Animation, Inc. Booth **61**
34 West St., So., Mount Vernon, N.Y.

Exhibiting: Portman Animation Stand and complete line of accessories.

Personnel: Warren Portman.

Precision Laboratories Div., Precision Cine Equipment Corp. Booth **20**
1037 Utica Ave., Brooklyn 3, N.Y.

Exhibiting: Precision Sound Readers for editing optical or magnetic soundtracks; unitized synchronizers; magnetic attachments for synchronizers; film slitters; editing devices for picture and sound; Noris 8mm Projector for synchronization with tape recorder.

Personnel: Irwin R. Sheldon.

Prestoseal Manufacturing Corp. Booth **5**
37-27 33rd St., Long Island City 1, N.Y.

Exhibiting: Prestoseal equipment for splicing dissimilar materials with a thermal setting reinforcing agent, used with Presto Buttweld Splicer to heat-seal similar or dissimilar materials; 16mm, 35mm and 70mm buttweld splicers; digital paper tape splicer.

Personnel: Leonard A. Herzig.

Polaroid Corp. Booth **6**
730 Main St., Cambridge 39, Mass.

Exhibiting: New Model 900 Camera; new Model 110B Camera and other film products. The demonstration will include the photographing of oscilloscope traces, using the Polaroid Land Roll Film Back and Polaroid Land Projection Film. These slides will be used to demonstrate the Pola-Land Optical Picture Comparator.

Personnel: R. Thomas B. Peirce, Jr., Rolf M. Augustin, Jr., Robert S. Quackenbush, Jr., Joan H. Smith.

Traid Corp. Booths **23, 24**
17136 Ventura Blvd., Encino, Calif.

Exhibiting: Intermediate and high-speed cameras, including 16mm-1B Photosonics Camera, speed to 1000 frames/sec; miniature Traid 15, operating speed, 100 frames/sec; accessories.

Personnel: R. F. Peterson, Fred G. Roberts, Jr., Carlos Elmer, Al Uremovich.

Westinghouse Electric Corp., Lamp Division Booth **25**
1 MacArthur Ave., Bloomfield, N.J.

Exhibiting: Small, compact light sources for high-speed photography; high wattage and sealed-beam lamps.

Personnel: W. R. Wilson, F. H. Rixton and R. J. Stefany.

Wollensak Optical Co. Booth **3**
850 Hudson Ave., Rochester 21, N.Y.

Exhibiting: Wollensak Optical 28 Models of Fastax-Fastair High-Speed Motion-Picture Cameras; accessory equipment; new reversal-negative 16mm portable film processor; Mirrotel lenses and boresights; Pro-Raptar lenses, series covering 35mm and 70mm formats; various photographic instrumentation products.

Personnel: Fred M. Emens, Charles B. Wade, Richard R. Youso, David C. Gilkeson, George K. Czarnikow, Robert B. Herden, Richard J. Wollensak.

Carl Zeiss, Inc. Booths **31, 32**
485 Fifth Ave., New York 17

Exhibiting: Mach-Zehnder Interferometer, an instrument used for measurement of density changes in transparent media by means of light interferences. Applications include measurements of fluid flow (particularly in wind tunnels and shock-wave tubes), sound phenomena in liquids and gases, temperature distribution in the environs of heated substances, and measurements in flames.

Personnel: Dr. Walter Kinder, Karl Windel.

Zoomar, Inc. Booths **45, 46**
55 Sea Cliff Ave., Glen Cove, N.Y.

motion-picture apparatus factories. (S. C. G.)—(I) N. A. Isaev. (II) A. I. Perminov. (III) V. K. Karpov. *Tekh. Kino i Televideniya*, 4:51-9, Jan., 1960, (in Russian).

A Seven-Lens Objective for Motion-Picture Cameras With a Mirror Shutter

For increasing the back focal length of an objective and also correcting distortion, curvature of field, and astigmatism, in the front part is placed a negative component consisting of two lenses: the weak positive meniscus convex placed towards the positive component of the objective. By the introduction of the front negative component into an objective with a focal length of F = 28mm, the back focal length is equal to 1.15 F. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] Russian 115, 231. M. M. Rusinov, M.I. Kuzlmina. Filed June 20, 1953.

FILM AND ITS PROPERTIES

[Soviet] Standard on Apparatus (Micrometers) for the Measurement of the Length of Motion-Picture Film Stock and Motion-Picture Films (Gost 9810-58)

A brief description of the standard, GOST 8910-58, *Apparatus for the Measurement of the Length of Motion-Picture Stock and Motion-Picture Films (Micrometers): Basic technical requirements*, is given. [Abstractor's Note: The discrepancy between "9810–58" in the title and "8910-58" in the text exists in the original.] (S. C. G.)—*Tekh. Kino i Televideniya*, pp. 65–7, Dec., 1959 (in Russian).

Some Factors in the Plasticizing Process of Cellulose Triacetate Motion-Picture Film

The brittleness of triacetate film compared with that of nitrocellulose film is a problem which is aggravated by the difference in shrinking properties: the difference between the shrinkage of the emulsion layer and the relative lack of shrinkage of the triacetate film setting up stresses in the latter. A range of plasticizers has been studied, and it is concluded that plasticizers based on esters of the higher fatty acids with from six to sixteen carbon atoms in the acid radical and from one to nine atoms in the alcohol radical are compatible with partially hydrolyzed fibrous cellulose triacetate in the quantities necessary for lowering the brittleness of the base. To some extent, the compatibility depends on the temperature and relative humidity. The structure of the alcohol radical is important: with a given number of carbon atoms in the acid radical, plasticizing action improves with increase in the number of carbon atoms in the alcohol radical. (S. C. G.)—L. V. Rozental', M. I. Mumzhiev, Z. K. Averbukh, and A. F. Mukovina. *Tekh. Kino i Televideniya*, pp. 12–17, Dec., 1959, (in Russian).

New High-Speed Motion-Picture Negative Film, Type E

A new, Soviet-produced, motion-picture negative film is described. If the speed of an earlier type of film, AM-1, is taken as equal to 1, the new film has a speed of 2.5 for a light source of color temperature of 5000 K. and 4 to 5 for a light source with color temperature of 3000 K. On the same rating, Kodak Tri-X Film has speeds of 2 to 2.5 for both sources. The new film has a better spectral response, lower graininess, and better resolution than earlier Soviet films of the same or higher speeds. Intended for news and art films under unfavorable conditions of natural light, and especially in artificial light, it is the product of collaboration between NIKFI and the Soviet No. 3 Film Factory. (S. C. G.)—A. O. Kondakhchan, S. A. Verkhovets, and G. G. Shevyakov. *Tekh. Kino i Televideniya*, pp. 16–18, Nov., 1959.

COLOR PHOTOGRAPHY
COLOR DEVELOPMENT

Photoacoustic Characteristics of Soundtracks on Color Multilayer Motion-Picture Film With Separate Processing

A study has been carried out of the photoacoustic characteristics of the soundtrack on multilayer motion-picture film with different methods of separate processing. In the conclusions, it is shown that, instead of the accepted method it is convenient to introduce into production a method of separate bleaching of the image, so that the silver reduced during the color development is completely preserved on the soundtrack. It is also suggested that film prints should be issued in two forms: with the soundtrack intended for use with antimony-caesium photocells, and with sound tracks intended for working with caesium oxide photocells. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya.*] A. V. Tsirulina. *Trudy Leningrad. Inst. Kinoinzhener.*, pp. 5–34, No. 5, 1959.

An Index of Photographic Activity of Diffusing Couplers in Color Development

A description is given of work done on the influence of different diffusing couplers on the rate of color development, by an estimation of the rate of development of a silver image; an attempt to explain the laws of color development on the basis of the results obtained; and the establishment of a method of quantitative characterization of the reactivity of color-development couplers. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] B. A. Chartoriiskii and V. S. Chel'tsov. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 16–23, No. 29, 1959.

An Index of the Reactivity of Nondiffusing Couplers by the Magnitude of the Energy of activation of the Color Development Process

A report is given of the results of a study in which, in particular, it was confirmed that there is a straight-line relation between the logarithm of the rate of development and the reciprocal of the absolute temperature, corresponding to the Arrhenius equation, for color development in the temperature range, 10 to 25 C. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] S. P. Sharlanzhiev and V. S. Chel'tsov. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 24–32, No. 29, 1959.

A Study of a New Form of Processing of Multilayer Color Negative Film

A study has been made of the effect of processing with pastes by the NIKFI method on the sensitometric properties of multilayer negative materials. It is shown that, for the present Soviet multilayer film, Type DS-2, such a change is completely feasible. (S. C. G.)—[Translated from *Referativnyi Zhur, Fiz.*] A. Wrzesinski. *Tech. Kinematogr.*, pp. 32–5, No. 9, 1957.

Matrix Films for Imbibition Printing

Results are given of work carried out at NIKFI, together with Film Factory No. 3 (Shostka), on the elaboration and manufacture of a set of matrix films adequately balanced for contrast. It is shown that the coefficient of contrast of the films approximates to the optimal for printing the matrices immediately from the color negative. The contrast of the relief image, within necessary limits, can be lowered, providing a corresponding choice of conditions for printing the matrices. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] S. A. Bongard. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 73–80, No. 29, 1959.

Effects of the Absorption of Light by a Layer of Matrix Film on the Gradation of the Photographic Relief Image

Results are given of studies of the effects of a change in the spectral sensitivity of an emulsion, the absorption of light by the emulsion layer, and the composition of the printing light on the gradational properties of a matrix film. It is shown that alteration of these factors controlling the depth of penetration into the emulsion layer of the actinic radiation gives rise to an important change in the gradation of the relief image. (S. C. G.) [Translated from *Tekh. Kino i Televideniya*] S. A. Bongard. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 81–92, No. 29, 1959.

A Study of the Processes of Color Development

An account is given of methods worked out for the determination of the leuco basis of azomethine dyes derived from 4 - (4′ - diethyl - 2′ - methylphenylimino) - 3 - methyl - 1 - phenylpyrazol 5 one and 4 - (4′d iethylphenylimino) - 3 - methyl - 1 phenylpyrazol - 5 - one, based on the potentiometric titration with iodine of an aqueous-alcoholic solution of the leuco base stabilized with an inorganic acid. With the aid of this method, it is shown that, on reduction of the dyes, the corresponding leuco bases, containing two hydrogen atoms more than the dyes, are formed. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] A. S. Kheinman and V. S. Chelltsov. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 5–15, No. 29, 1959.

The Influence of a Yellow Light Filter Layer on the Resolving Power and Effective Speed of Color Negative Materials

Results are given of work undertaken to decide whether a yellow light-filter layer, containing colloidal silver and generally placed between the top and middle emulsion layers of the film, decreases the resolving powers of the middle and lower emulsion layers. (S. C. G.)—[Translated from *Tekh, Kino i Televideniya*] I. M. Kilinskii and A. N. Iordanskii. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 59–61, No. 29, 1959.

FILM PROCESSING (APPARATUS AND CHEMICALS)

A Study of a Friction Film-Transport Mechanism with Automatic Maintenance of the Constancy of Tension of the Film, in Which the Upper Axle With the Driving Roller Rotates While the Lower Axle is Fixed

The results are given of a study made on film-transport mechanisms of the following types: with single-loop transport of the film, and with a friction drive. Curves are obtained for the tension of the film for different variations in the construction of the film-drive mechanism and other factors. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] I. S. Golod. *Inf.-tekh. Byul. TsKB Min. Kultur. S.S.S.R.*, pp. 17–29, No. 4 (18), 1958.

A Study of a Section of a Multiloop Friction Film-Drive Mechanism With Rotating Upper or Lower Axles, on Which all the Rollers Are Free

Mechanisms with rotating upper axles, and with rotating lower axels have been studied. Numerical data and schemes of distributing the tensions of the loops of film for different variations in the construction of the mechanism are obtained. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] I. S. Golod. *Inf.-tekh. Byul. TsKB Min. Kultur. S.S.S.R.*, pp. 18–24, No. 5 (19), 1958.

A Comparative Analysis of Some Forms of Film-Transport Mechanism in Developing Machines

Consideration is given to a section of a five-loop, film-transport mechanism with drive pulleys of different types, set on ebonite bearings, fluoroplastic bearings, and on roller bearings of vinyl plastic. Experimental curves for $\Delta p = f(Q_1)$ are derived, as well as formulas for calculation and graphs showing the distribution of forces in the length of film in one section of the film-transport mechanism with drive pulleys of different types. An analysis is made of film-transport mechanisms, and practical recommendations are given. (S. C. G.)—[Translation of Author's Abstract] I. S. Golod. *Tekh. Kino i Televideniya*, pp. 32–5, December, 1959 (in Russian).

Improvement of the Properties of Motion-Picture Films and Their Processing

The author makes a number of personal suggestions for the improvement of films and processing in the Soviet Union, and the article is printed by the editorial board of the Russian journal with the purpose of provoking discussion. It covers developing machines, printers, auxiliary apparatus in processing, the developing processes themselves, the photographic properties of motion-picture film, and the organization of production. (S. C. G.)—E. A. Iofis. *Tekh. i. Televideniya, 4:*33–36, Jan., 1960 (in Russian).

PRINTING AND OPTICS

A [Soviet] Standard on Motion-Picture Objectives for Cinematography with 35mm Film and Interdepartmental Standards on Methods of Testing Objectives

A brief note is given on the standard GOST 6741-58, which became effective in 1959, and on the interdepartmental standards, MN61-59, MN62-59, MN63-59, MN64-59, and MN65-59. (S. C. G.)—*Tekh. Kino i Televideniya*, p. 65, Dec., 1959, (in Russian).

Lighting Systems With Devices for Supplementary Alternation of the Illumination of the Printing Gate of Printers

In motion-picture positive printers, the illumination at the printing gate is altered according to the printing characteristics of the negative. Devices are considered for carrying out an independent alteration of the light to compensate for fluctuations in the output of the incandescent lamp. (S. C. G.)—M. G. Shamshteĭn and S. N. Podlesnykh. *Tekh. Kino i Televideniya*, pp. 25–31, Dec., 1959 (in Russian).

A Photographic Method for Measuring the Temperature of Light Sources

Some photographic methods of measuring brightness temperature and color temperature and color temperature are described. For the determination of brightness temperature of the surface to luminous transparent bodies a method is possible which is based on the comparison of photographic densities formed by unknown and standard light sources, within the limits of a fairly narrow spectral region, subsequently referring the results to the given wavelength. In essence, the practical realization of this method depends on a number of simplified assumptions, in particular, on the linear relation between the density and exposure; Wien's law is used for the spectral distribution of the energy of radiation, but, at temperatures higher than 4000 K., it is necessary to use Planck's law, determining the light flux by means of numerical integration. Consideration is given to the possibilities of also determining the brightness temperature in the case of cavity radiation. For determining the color temperature, the authors propose two methods: by using the "blue/red" ratio (i.e., the ratio of the brightness in two sufficiently separated parts of the spectrum); and by the relative spectral distribution of energy [i.e., the linear relation between $\log(\beta\lambda^{\circ}\lambda^{5})$ and $1/T$, deriving from Wien's law]. In the first case, to obtain the required data, it is essential to take into account departures from additivity of the photographic action of radiation with different spectra compositions; and in the second, that Wien's law, the limits of which are restricted, is observed. Photographic errors (nonuniformities of the emulsions and their development) depend on the magnitude of the measured temperature: at 10,000 K. they do not exceed ± 1.5% for brightness temperature and ± 6% for color temperature. (S. C. G.)—[Translated from *Referativnyi Zhur Fiz.*] S. G. Grenishin, A. A., Solodovnikov, and G. P. Startsev. *Trudy Komiss. po Pirometrii pri Vsesoyuz. Nauch.-Issled. Institut. Metrol.*, pp. 57–68, No. 1, 1958.

Problems of the Stability of the Motion-Picture Image

A study is made of the conditions for obtaining a steady image in the printing of special-effects films involving intermediate positives and negatives, with special reference to the positioning of the registration pin in the camera, printer, and projectors used. (S. C. G.)—Ya. L. Leĭbov. *Tekh. Kino i Televideniya*, *4*:27–30, Feb., 1960 (in Russian.)

Special Effects Cinematography in the Production of Films by the Electronic Method

A survey is made of the basic forms of electronic special-effects cinematography in the production of films by the electronic method, based on obtaining an image on a kinescope screen with subsequent recording on motion-picture film. (S. C. G.)—[Translation of Author's Abstract] V. A. Burgov. *Tekh. Kino i Televideniya*, *4*:31–8, Feb., 1960 (in Russian).

Afocal Optical Systems and Their Use in Motion-Picture Techniques

The necessity for using interchangeable lenses of different focal lengths for motion-picture and still photography is described. The design principles of afocal mountings for these lenses are discussed. (C. A. B.)—[Translation of Author's Abstract] J. Picman. *Jemna Mechanika a Optika*, *4*:336–40, Oct., 1959 (in Czech).

Apparatus for Printing 16mm Films With Magnetic Sound Tracts

Some details are given of the development work on the Soviet-made KMP-3 apparatus intended for carrying out one of the last operations in the process of manufacture of 16mm copies, the placing of the sound on the film. This operation is carried out by transcribing onto the magnetic track of the film copy the original magnetic soundtrack recorded on a 35mm perforated sound carrier. (S. C. G.)—[Translated from Tekh. Kino i Televideniva] G. K. Khanova. *Informats.-Tekh. Byul. TsKB Minist. Kultury SSSR*, pp. 3–20, No. 2 (21) 1959.

SENSITOMETRY AND IMAGE STRUCTURE

Correlation of the Basic Sensistometric Properties of Photographic Emulsions With Those in Color Development

Results are given of an investigation undertaken to explain the connections between the [black-and-white] speed and contrast of emulsions and the properties of emulsions when color-developed. From the experimental results, it can be concluded that, on color development, speed for the dye image, S_{λ}, is equal to the speed for the silver image, $S_{\lambda_{Ag}}$, multiplied by the ratio $D_{\lambda}/D_{\lambda_{Ag}}$. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] T. V.

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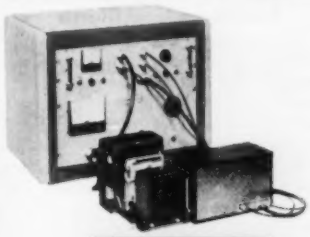

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Abramova and V. S. Chel'tsov. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 33–42, No. 29, 1959.

Studies of the Ability of Photographic Materials to Reproduce Small Elements of an Optical Image. III. The Influence of the Conditions of Positive Printing on Reproduction of Two-Dimensional Objects

The correctness of the photographic reproduction of small, two-dimensional elements of an optical image as a result of a two-stage photographic process is characterized as satisfactorily by the magnitude of the resolving power in the positive image as it is when only the negative stage of the process is carried out, the resolving power of the negative material then serving the same purpose. (S. C. G.)—(Translation of Author's Abstract] Yu. K. Vifanskii, Yu. N. Gorokhovskii, and N. D. Khrul'kova. *Zhur. Nauch. i Priklad. Fotografii, 5*:14–19, No. 1, Jan.-Feb., 1960 (in Russian).

Scattering of Light by Opal Glasses and Their Use in Densitometry

The Russian sensitometric standard, GOST 2817-50, specifies that the densities of a step wedge should be read with the emulsion surface in contact with an opal glass, the thickness of which should be such that no increase in it will influence the results. This specification was considered to be inadequate, in view of the different properties of different opal glasses. Accordingly, a study was made of the light-scattering properties of a number of Soviet-produced opal glasses, together with one foreign one, and an opal plastic. The angular distribution of scattered light from the opal glasses is tabulated. (S. C. G.)—V. A. Korndorf and I. H. Chernyi. *Zhur. Nauch. i Priklad. Fotografii i Kinematografii*, **4**: 430–32, No. 6, Nov./Dec. 1959.

Sensitometry of Black-and-White Reversal Motion-Picture Film

Processing formulas and directions are given for the sensitometry of reversal motion-picture films. The sensitometric characteristics are discussed, and it is suggested that the reversal speed should be expressed as the reciprocal of the exposure required to give a final (positive) density of 1.5. In the sensitometric testing of reversal films, it is recommended that a family of positive characteristic curves be obtained for different times of first development, and, that, from these, the reversal speed, gamma, minimum density, and maximum density, should all be determined in relation to the length of the first development. The speed then quoted on the package should be that obtained with development conditions giving a minimum density of 0.05. Results of such tests are given for a Soviet reversal film and a number of foreign films. (S. C. G.)—S. S. Gilev and L. V. Kiseleva. *Tekh. Kino i Televideniya*, pp. 18–27, Aug. 1959.

PROJECTION

[Soviet] Standards for Anamorphic Optical Systems and Attachments for Cinematography and Projection with 35mm Wide-Screen Motion-Picture Films

Two new Soviet standards became effective Jan. 1, 1960. They are GOST 9040-59 Optical Systems for Anamorphic Cinematography and Anamorphic Attachments for Motion-Picture Objectives, and GOST 9039-59 Anamorphic Attachments for Motion-Picture Projector Lenses. They are briefly reviewed. (S. C. G.)—*Tekh. Kino i Televideniya*, pp. 65–6, Dec., 1959. (in Russian).

Automatic Control of a Motion-Picture Projector Arc Lamp at 15000 Lumens

A description is given of a system of automatic control of a motion-picture projector arc lamp at 15000 lumens, developed in the Illuminating Engineering Laboratories of NIKFI. Tolerances in the focusing requirements are formulated. A photorelay is described for maintaining the crater of the positive carbon in the focus of the optical system, using a photoconductor as the radiation-receiving element. The results of a trial of the photorelay are set out, together with a device for striking the arc and automatically maintaining its length. (S. C. G.)—[Translation of Authors' Abstract] T. V. Derbisher and V. V. Piskunov. *Tekh. Kino i Televideniya*, pp. 19–24, Nov., 1959.

National [Soviet] Standard on 8-mm Motion-Picture Projectors for Amateur Use.

A brief note is devoted to the Standard, GOST 9100-59, *Amateur Motion-Picture Projectors for 8mm Motion-Picture Films. Fundamental Parameters.* This standard became effective Jan. 1, 1960.' (S. C. G.)—*Tekh. Kino i Televideniya*, 4:71, January, 1960 (in Russian).

The FKS 1 Film-Viewing Table

The FKS-1 film-viewing table is an experimental model intended for the examination of films in archives and gives facilities for listening to the sound record as well as for viewing the picture. Its construction is described. (S. C. G.)—I. A. Ratushnyak. *Tekh. Kino i Televideniya, 4*:58-60, Feb., 1960 (in Russian).

The De-Anamorphizing of Wide-Screen Films

An analysis is given of a method of de-anamorphizing images without the use of cylindrical optics. It makes it possible to prepare the usual type of film for exhibition on screens with the aspect ratio of 1:1.38 from an anamorphic negative with the aspect ratio of 1:2.55. (S. C. G.)—(Translation of Author's Abstract] A. G. Boltyanskii. *Tekh. Kino i Televideniya, 4*:1–10, March, 1960 (in Russian).

New Members

The following members have been added to the Society's rolls since the April 1960 *Directory*. Also listed are those regretfully reported as deceased since the *Directory*. The designations of grades are the same as those used in the Directory. An up-to-date list of the Sustaining Members appears on the outside back cover of each month's *Journal*.

Fellow (F) Active (M) Associate (A) Student (S)

Deceased

James F. Cornell (M) *Alfred F. Kleindienst (M)* *Hollis W. Moyse (F)*
Jay E. Gordon (M) *Peter Mole (F)* *Ronald A. Nieth (A)*
Edward W. Kellogg (H)

Errata

Superseding the erroneous errata re: **Goetz, Jack M.,** in the August *Journal*, please *read:*

Goetz, Jack, Sales Administrator, Consolidated Film Industries. Mail: 1148 San Ysidro Dr., Beverly Hills, Calif.

Goetz, Jack M., Director of Public Relations, Consolidated Film Industries. Mail: 147 Via Los Miradores, Redondo Beach, Calif.

Adams, Robert B., Eng., Dir., WKRC-TV Taft Broadcasting Co. Mail: 3347 Sherlock Ave., Cincinnati 20, Ohio. (A)

Agbe-Davies, Anthony A., Univ. So. Calif. Mail: 1744 S. Harvard Blvd., Los Angeles 6. (S)

Alberts, Cecil D., Independent Plastics Mfrer., 670 Gould Ave., Los Angeles. (A)

Allen, Charles S., Cameraman, Editor, Thiokol Chemical Corp. Mail: 725 W. Arbor Dr., Huntsville, Ala. (A)

Amer, Salah, Deputy General Mgr., UAR Broadcasting, 4 Sherifein St., Cairo, Egypt. (M)

Applegate, George W., Elect. Eng., Research & Devel. Labs., U.S. Army Signal Corps. Mail: 1720 "L" St., West Belmar, N.J. (A)

Ashley, Douglas J., Asst. Lab. Supvr., National Film Unit. Mail: 6 Stephen St., Tawa, Wellington, N.Z. (A)

Aung, Tin Gyi, Planning Dir., Directorate of Films & Stage, Govt. of Burma. Mail: 153/155, Theinbyu Rd., Kandawgalay, Rangoon, Burma. (A)

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Babcock, David L., Supt. Mot.-Pic. Prod. Devel., Eastman Kodak Co., A&O Div., 400 Plymouth Ave. N., Rochester 4, N.Y. (M)

Bacon, Capt. Noel R., USN, 3480 N. Venice St., Arlington 7, Va. (A)

Baker, Jerry L., Photo. Research Eng., RCA Service Co. Mail: Box 996, Cocoa Beach, Fla. (M)

Baker, Roy, A-V Educationalist, 8 Edgecumbe Rd., Tauranga, N.Z. (A)

Baker, Wayne E., Univ. So. Calif. Mail: 4614 Rodeo La., Los Angeles 16. (S)

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Barrington, Nelson, Pres., TV-R Inc., 426 E. 58 St., New York 22. (A)

Bass, Donald, Sales Eng., Flight Research Inc. Mail: 116-55 Queens Blvd., Forest Hills 75, N.Y. (M)

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Beckley, William M., Film Dir., John L. Douglas & Associates, Inc., 1101 29 Ave. W., Bradenton, Fla. (A)

Bell, James B., Jr., Professional Products Sales & Service, General Aniline & Film Corp., Ansco Div. Mail: 341 Hillsdale Ave., Santa Clara, Calif. (M)

Bellwood, LeRoy A., Radio & TV Eng., KSFD Inc. Mail: 2875 Washington St., Lemon Grove, Calif. (M)

Benger, W. C., Engrg. Supvr., A-V Devel., Northern Electric Co., Ltd., Box 400, Belleville, Ont., Can. (M)

Berger, Hellmut H., Chief Eng., Video-Tape Div., Robert Lawrence Prod., Ltd. Mail: 105 Isabella St., Apt. 912, Toronto, Ont., Can. (M)

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Branch, Eyre, A-V Cons., 123 Greenacres Ave., White Plains, N.Y. (A)

Braymer, Don G., Head, Photo. Unit., The Upjohn Company, Kalamazoo, Mich. (A)

Breitbord, Jacob L., Elect. Eng., Itek Corp. Mail: 6 Blackthorn Rd., Framingham, Mass. (M)

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Poteat, Bobby E., TV Eng., KQED. Mail: 77 Miguel St., San Francisco 12. (A)
Powers, Robert L., Jr., Elect. Techn., Bell, Howell & Co. Mail: 691 W. Center Rd., Palatine, Ill. (A)
Protay, Jacques, Film Techn., MGM Labs. Mail: 1330 Eighth St., Manhattan Beach, Calif. (A)
Provost, Frank, Sales Eng., Beckman & Whitley Co. Mail: Oak Dr., Mahopac, N.Y. (M)

Ramsey, Wade, Jr., Newsfilm Techn., WSOC-TV. Mail: 2628 Beechnut Rd., Charlotte 8, N.C. (A)
Rauffer, Walter M., Tech. Repr., TV Engrg., RCA Service Co. Mail: 119 Barker Ave., Eatontown, N.J. (A)
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Rebehy, El-Sayed A. E. S., Univ. Calif. L.A. Mail: Box 24741, Los Angeles 24. (S)
Reed, Donald E., Techn. Dir. R&D Lab., Reed Research Inc., 1048 Potomac St., N.W., Washington 7, D.C. (M)
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Reizner, Richard John, L.A. City Col. Mail: 6511 W. Olympic Blvd., Los Angeles 48. (S)
Renne, Paul J., Cameraman, Techn., RCA Service Co. Mail: 222 Skelly Dr., Rockledge, Fla. (A)
Rheinfelder, William A., Group Leader, Transistor Applications, Motorola, Inc. Mail: 4317 Calle Feliz, Phoenix, Ariz. (M)
Rigby, Peter P., Company Director, Robert Rigby Ltd. Mail: 14 Creighton Ave., London N. 10, Eng. (A)
Righini, Eugene F., Mot.-Pic. Timer, Movielab Film Labs. Mail: 274 McCloud Dr., Fort Lee, N.J. (A)
Robinson, Milton D., Dir. Sound Recording, General Electric Co., Film Prod. Oper. Mail: 5 Koon St., Troy, N.Y. (M)
Rochefort, Leonard E., Mot.-Pic. Photog., RCA Service Co. Mail: 1837 Ivy La., Winter Park, Fla. (A)
Rom, Rudolph A., Proj. Eng., Revere Camera Co. Mail: 4229 S. Clinton Ave., Berwyn, Ill. (A)
Rombeau, Robert E., Studio Supvr., KABC-TV. Mail: 1438 S. Edris Dr., West Los Angeles 35. (A)
Rose, Philip, Tech. Manager, Strand Electric. Mail: 57 Pine Crescent, Toronto, Ont., Can. (M)
Rosenberg, Philip R., Vice-Pres., Supervising Film Editor, Wolper, Inc. Mail: 9119 Sunset Blvd., Hollywood 46. (A)
Rossner, Gerard E., Rochester Inst. Tech. Mail: 126 Parkview Ter., Rochester 17, N.Y. (S)
Ruby, M., Head of Relations Exterieures et Documentation, F.N.I.E., 23 rue de Lubeck, Paris 16, France. (A)
Ruddell, Lawrence A., Dir. of Recording & Film Services, American Broadcasting Company. Mail: 35-55 73 St., Jackson Heights 72, N.Y. (M)
Rutledge, Jack L., Royal Melbourne Tech. Col. Mail: 7 Glentilt Rd., Gardiner, Melbourne, Vic., Australia. (S)

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Salter, W. Cary, Leader, Field Photo Crew, RCA Service Co. Mail: Merritt Island, Fla. (A)
Saylan, Ezel Ibrahim, City Col. N.Y. Mail: 75-19 197 St., Flushing, N.Y. (S)
Schaack, Robert J., Eng., AC Spark Plug Div., General Motors Corp. Mail: 4661 N. 90 St., Milwaukee 18, Wis. (M)

Schubeck, John D., Free-Lance Cameraman, 30 Lincoln Boulvd., Merrick, L.I., N.Y. (A)
Schwartz, Morton, Sound Techn., Vice-Pres., Recording Studios, Inc. Mail: 3640 Johnson Ave., New York 63. (A)
Scott, David W., Free Lance Sound-Mixer Cons., 5 Tudor City Pl., New York. (A)
Scott, Stuart Melby, Techn., N.Z. Govt., National Film Unit, Darlington Road, Miramar, Wellington, N.Z. (A)
Senkel, Gene, Lab. Maint., Western Cine Service. Mail: Box 7634, Lakewood 15, Colo. (A)
Seumatsu, Kenji, Camera Repair, Gordon Enterprises. Mail: 3814 W. Adams Blvd., Los Angeles. (A)
Shadare, Festus O., Sr. Info. Officer, Western Nigeria Government, Ministry of Home Affairs, Ibadan, Nigeria. (A)
Shah, S. Shafqat, Independent Film Prod. & Dir., 189-B/2, F.E.C.H.S., Karachi, Pakistan. (M)
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Shay, Ron E., Univ. So. Calif. Mail: 1179 W. 29 St., Los Angeles 7. (S)
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Shellenberger, Charles J., TV Techn., Film Control, Columbia Broadcasting Co. Mail: 204 Clayton Ter., Paramus, N.J. (A)
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Sips, Wilhelmus Gysbertus, Tech. Manager, N.V. Cinecentrum. Mail: Neuweg 501, Hilversum, Holland. (A)
Sisson, Elbert C., Cons. Chemical Eng., 1637 N. Stanley Ave., Hollywood 46. (M)
Smith, Alfred A., Mot.-Pic. Techn., N.Z. National Film Unit. Mail: 34 Chapman Crescent, NAB/NAE, Hutt City, N.Z. (A)
Smith, Norman A., Record. Studio Mgr., Radio Church of God. Mail: 811 New York Dr., Altadena, Calif. (A)
Smith, Richard B., Photo-Optical Equip. Techn., U.S. Naval Weapons Lab. Mail: Box 313, Dahlgren, Va. (A)
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Souers, William C., Optical Line-up (Revue Studio), Pacific Title. Mail: 5462 Marathon, Hollywood 38. (A)
Souther, Howard, Sales Manager, SONOTEC, INC., 503 S. Grand Ave., Santa Ana, Calif. (M)
Spalsbury, Jeff R., Editor, Mot.-Pic. Div., Ohio State University, 113 Townshend Hall, Columbus 10, Ohio. (A)
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Stanton, Thomas J., Production Mgr., Pat Dowling Pictures. Mail: 432 Fourth St., Manhattan Beach, Calif. (A)
Summerfield, Wesley, Tech. Publications, Service Literature Productions, Inc. Mail: 1027 Dodge Ave., Evanston, Ill. (A)
Swan, William D., Jr., Free-Lance Theatre & Mot.-Pic. Set Elect., 6320 N.E. Sixth Ct., Miami 38, Fla. (A)
Swisher, Charles F., Video Application Eng., Ampex Corp. Mail: 1121-G Woodside Rd., Redwood City, Calif. (M)

Tarr, Thomas A., Patent Administrator, Technicolor Corp. Mail: 3609 W. Alameda, Burbank, Calif. (M)
Tate, Franklin L., Salesman, Photo Importing Agencies Ltd. Mail: 345 Adelaide St. W., Toronto, Ont., Can. (A)
Taylor, Archer S., Cons. Radio & TV Eng.; Part-time Tech. Dir., Mont. State Univ. Mail: Box 1479, Missoula, Mont. (M)
Terr, Jerome, Projection Eng., Preview Theatres Inc. Mail: 68 Mountaindale Rd., Yonkers, N.Y. (A)
Thompson, John L., Jr., Prod. Coordinator, ABC-TV Network. Mail: 6907 Camrose Dr., Hollywood. (A)
Tichenor, Raymond B., TV Eng., WSM-TV. Mail: 739 Winthorne Dr., Nashville 11, Tenn. (M)
Tomlinson, David H., Bob Jones University. Mail: Box 4638, Greenville, S.C. (S)
Tremaine, Kenneth Alan, Mot.-Pic. Coordinator, McGraw-Hill Book Co. Mail: 32-47 82 St., Jackson Heights 70, N.Y. (A)
Tredwell, John, Mass. Inst. Tech. Mail: 305 Memorial Dr., Room 503-B, Cambridge 39, Mass. (S)
Trueblood, John B., Mot.-Pic. Printer, Pacific Missle Range. Mail: 1130 W. Cedar, Point Mugu, Calif. (A)
Trumble, Dennis R., Mot.-Pic. Photo, MDW U.S. Army Sig. Supt., Unit 7015, Fort Myer, Va. (A)
Tschiemer, Robert F., Manager, RCA, Field Photo., (Pict. Serv.). Mail: Box 394, Cocoa Beach, Fla. (A)
Tunick, Earle D., Comm. Photo., Johnston & Tunick, Inc. Mail: 7610 Colonial Rd., Brooklyn 9, N.Y. (A)
Twist, Thomas O., Photometry & Colorimetry Sect., National Bureau of Standards. Mail: Circle Dr., Glen Hills, Rockville, Md. (M)

Udey, Edwin C., Dir. of Photo., Cenco Educational Film Co., 1700 Irving Park Rd., Chicago 13. (A)
Unger, Jack M., Chief, Photo. and Mech. Lab., Bell & Howell Co. Mail: 1024 Marion Ave., Highland Park, Ill. (M)
U-Nyi-Htwe, Director-Cameraman, Govt. Films & Stage Dept., 35 A, Hermitage Rd., Rangoon, Burma. (A)
Urban, Ron, Entertainer, 944 N. Noble, Chicago 22. (A)
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Vachon, Ambrose H., Supt. Engrg. Div., National Film Board. Mail: Box 6100, Montreal, Que., Can. (A)
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Vendegna, George, Sr., Timer, Pathe News. Mail: 160 President St., Hempstead, N.Y. (A)
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Vinten, William P., Director, W. Vinten Ltd., 715 N. Circular Rd., London, N.W. 2, Eng. (M)

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Wildum, Paul, Owner, Cine 60, Mot.-Pic. Equip., 450 West End Ave., New York 24. (M)
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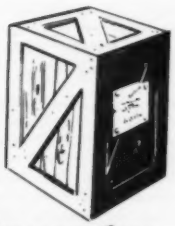
Wisner, David, Mot.-Pic. Producer, Cenco Educational Film Co., 1700 Irving Park Rd., Chicago 13. (A)
Woll, Yael R., Dir., Inst. of Film Techniques, City Col. N.Y. Mail: 251 W. 92 St., New York 25. (M)
Woodman, Roger C., A-V Serv. Mgr., Coast Visual Education Co. Mail: 3700 W. 109 St., Inglewood 2, Calif. (A)

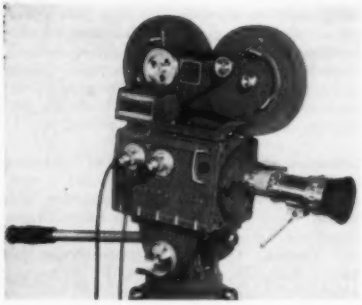
Zemlo, Alfred M., Free-Lance Recording Sound Techn., Film Arts Productions. Mail: 421 Haskell St., Beaver Dam, Wis. (M)
Ziegler, Sigurd, Elect. Eng., Convair Electronics. Mail: 4120 Taos Dr., San Diego 17, Calif. (M)
Zimmerman, Robert H., Mot.-Pic. Producer, Dixie Films. Mail: 4451 Chickasaw Rd., Memphis, Tenn. (M)
Zvarich, Emil N., Video Tape Recording & Editing Eng., American Broadcast Paramount Theatres. Mail: 6170 Rodgerton Dr., Hollywood 28. (M)



new products

(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.



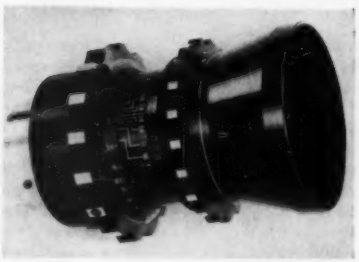
A new lightweight version of the Pro-600 camera, designed especially for documentary filming and TV news coverage, has been announced by Bach Auricon, Inc., 6900 Romaine St., Hollywood 38. The design of the new camera, called the Pro-600 Special Model CM-77, is based on a lightweight, high-torque, synchronous "soundrive" motor specially designed for this particular camera. Self-blimped for quiet operation, the camera is prepared for magnetic single-system sound. Optical single-system sound, or double-system magnetic and optical sound are also available. The camera is 16mm and all-transistorized. The cost ranges up from $1295.00, depending on features and options required.

A new color camera tube, the RCA 4401, announced by Radio Corp. of America, has been designed to originate color programs at light levels no higher than those used for black-and-white broadcasts. Used originally to cover night baseball games, National Broadcasting Co. plans to use the new tubes in its color broadcasts. New schedules call for changing one evening and two daytime programs to color, increasing color programming from 720 hours in 1959 to 1000 in 1960

Tripod legs, newly designed for use with CECO Professional Junion Tripods, have been announced by Camera Equipment Co., 315 W. 43 St., New York 36. Designed for greater rigidity, the tripod legs are equipped with double knob leg locks to assure equal pressure on each leg. They have been designated CECO Heavy Duty Tripod Legs.

Omnitar telephoto lenses, distributed in the United States by Birns & Sawyer Cine Equipment Co., 6424 Santa Monica Blvd., Hollywood 38, are available in 12 separate focal lengths ranging from 125mm through 2000mm with individual lens mounts for 28 cameras covering the 16, 35 and 70mm format films. Also available are monocular Omniscopes used as tracking finders; and lens-to-camera support cradles designed to lock both units into a vibration-free system. These lenses are constructed for versatility in use on various types of cameras in addition to "C" mount cameras. The lenses, designed especially for use on missile bases and military installations, are also used in various industrial applications. Prices range from $152.50 for the 5-in. lens to $795.00 for the 40-in. lens.

Twenty-six new types of optical glass designed by the Schott Glass Works, Mainz, Germany, and distributed in the United States by Fish-Shurman Corp., 85 Portman Rd., New Rochelle, N.Y., have been announced. Most of these new glasses are reported to have extremely high refractive indexes and low dispersion values and to have little, if any, inherent color. The glasses are also said to be extremely resistant to atmospheric impurities and to the etching effect of weak acid and to contain a minimum of internal bubbles and striae.



A new series of Super Baltar lenses designed for motion-picture, television and special purpose applications has been announced by Bausch & Lomb Optical Co., Rochester 2, N.Y. The series, incorporating a newly designed optical system, includes eight lenses with focal lengths ranging from 20mm to 9 in. (speed of $f/2.0$, both f and T stopped). All focal lengths cover 35mm motion-picture frame and lengths from 3 in. to 9 in. cover 70mm frames. Back focal lengths range from 33mm to 133mm.

A new film processing machine for negative, positive and soundtrack is manufactured by Allen Products Inc., Milford, Conn., and distributed by S.O.S. Cinema Supply Corp., 602 W. 52 St., New York 19. The machine, designed to process film at speeds up to 660 ft/hr, is a self-contained unit containing a compressed air squeegee, variable-speed drive and a specially designed plumbing system to permit draining and back flushing of tanks. It is priced at $1995.

A film slitter has been designed specifically for film used by the Dynafax high-speed camera produced by Beckman & Whitley, 973 San Carlos Ave., San Carlos, Calif. The camera, designed to operate at a speed of 26,000 pictures/sec, uses special film in the form of 16mm frames side by side on a 33¼-in. strip of 35mm film. The film has an unusual arrangement of sprocket holes. The slitter is constructed so that the 35mm strip can be cut into two 16mm strips of standard single-perforation film.

Anscochrome Duplicating Film Type 544, a 35mm reversal color film designed for duplicating positive color transparencies and positive film strip originals, has been announced by Ansco, Binghamton, N.Y., the photographic manufacturing division of General Aniline & Film Corp. This film is used for making "blow ups" from 16mm originals and may also be used for making prints directly from 35mm motion-picture projection prints. It is compatible with Anscochrome film and may be processed in Anscochrome chemicals. It is priced at $13.50 per 100 ft for darkroom loading and $14.65 per 100 ft for daylight loading.

Tape recorders convertible from ¼-in. to ½-in. tape have been announced by Bogen-Presto Co., Box 500, Paramus, N.J. These are described in an 8-page catalog, "Presto 800 Series Profession Tape Recorders," available from the company.

employment service

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Motion Picture Editor and Cameraman. Presently with N.E.T.R.C. Math Study Film Project at Univ. of Ill. as Head Editor and Head Cameraman. Formerly with N.O.T.S. China Lake as Cameraman and Editor. B.A. and part M.A. from Univ. of Southern Calif. Dept. of Cinema. Also experienced in motion picture laboratory, still work, and other aspects of film production. Interested in a challenging position with potential. Write or telephone for resume or Form 57; day: EMpire 7-6611, ext. 3837; night: EMpire 5-1038; Stanley Follis, 1311 South Cottage Grove, Urbana, Ill.

Sound Engineer. Young Indian desires position as sound engineer in a well-established organization. Brilliant academic career. Graduate in Science. Three years Diploma in Sound Engineering. Well versed in equipment maintenance and procedures and motion-picture laboratory practice. Enterprising and hard-working. Prepared to work as 'Apprentice Trainee', if desired. Member of Audio Engineering and Associate Member of SMPTE. Write: M. K. Srivatsa, 17, Rangarao Road, Shankarapura, Bangalore-4, India.

Trainee. Israeli student, 31, motion pictures graduate UCLA '60, speaks 7 languages, with rich background in public relations, needs opportunity for practical training in any phase of cinematography or television production. Will travel. New York or Los Angeles areas preferred. Write P.O. Box 24533, Los Angeles 24.

Writer-Producer. Young man, 27, with college background in documentary film production. Have written and produced business and training films with top Chicago studio and educational films for largest studio in the field. Desire position with film producer anywhere in U.S.A. or abroad. Write B.K., 820 W. 79th St., Chicago 20, Ill.

Cameraman. Presently employed shooting special photographic effects, miniatures, inserts, mattes, rear projection, and stop-motion animation for a special-effects company. Have experience with black-and-white, Ektachrome and Eastman Color, also CinemaScope, on feature films, TV commercials, TV series and industrials. Employed 2 years on TV series as dimensional animator, later as production manager on same cartoon series. Also experienced with editing and A & B roll cutting. USC degree. Age 28, single. Desire position with educational, commercial or industrial film company. Resume on request. R. Rodine, 5636 Laurel Canyon Blvd., North Hollywood, Calif. POplar 1-0728.

Cinematographer. Motion-picture or visual aids specialist. 1960 grad. Univ. Calif., B.A. in motion pictures. U.S. citizen, born and raised in Germany. Two languages fluently. One yr professional experience as director photog. with TV advertising agency in 16mm motion-picture and TV slide-film production. Serious student cinema since age 12. Also experienced sound recording and as projectionist, 16 & 35-mm. Interested in career job, technical and creative end theatrical or industrial film production. Age 31. Prefer U.S. but free to travel. Member SMPTE and IATSE. Write: Dieter W. Kaisenberg, P.O. Box 1142, Hollywood 28.

Electro-Mechanical-Optical Engineer. Graduate, 10 yrs experience in development, research and design of precision instruments. Presently employed as supervisory engineer. Optical patent currently being processed. Attending evening graduate physics courses. Desire challenging work in optical instrumentation and/or design; will consider related work. Resume and references upon request. Harry Silver, 65-61 Parsons Blvd., Flushing 65, N.Y. OL 8-0133.

Educational TV and Motion-Picture Administrator and Consultant. Experienced in every phase of ETV administration, programming, production and teaching, open and closed circuits. Also broad background in mass communications; Ph.D. Consultant on design and use of TV and film equipment, communications curricula, instruction by and for TV. Design of studios, either new building or revamping any size present space. Box 1143, Jacksonville Beach, Fla. CHerry 6-2269.

Writer, Director, Cameraman available for special Civil War Centennial projects. 14 yrs experience in all phases motion-picture and TV work. Writing credits in national magazines, trade journals and films. Know and have written on Civil War subjects and locations. Will handle assignments for producers working on films or presentations for upcoming Centennial Celebration. Write R. Krepela, P.O. Box 7331, Atlanta 9, Ga.

Positions Available

Motion - Picture Production Salesmen. Excellent opportunity for men in all corners of the world to affiliate themselves with a new motion - picture production unit. Salesmen should have contacts in industry, public relations and advertising fields to sell motion-picture and film-strip productions. Write giving full details of area you can cover. Allegro Film Productions, 723 Seventh Ave., New York 19.

Sales Manager/Sound Studio. To develop and carry out sales-marketing program to sell sound recording service to film producers, advertising agencies and broadcasters. Technical background in recording techniques plus understanding and know-how as to sound problems of users required. Special emphasis on video tape services. Send resume and salary requirements in full confidence to W. P. Fiske, 1 East Putman Ave., Greenwich, Conn.

Film Inspectors, Film Librarian. Temporary or permanent. Write or call Peerless Film Processing Corp., 165 W. 46 St., N. Y. 36 Tel. PLaza 7-3630. Att: Kern Moyse.

Sales Engineers. For electronic equipment, closed-circuit TV, etc., in districts of Boston and Chicago. Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N. J. CEnter 9-6100.

Motion-Picture Timer. Experienced technician for color filmstrip laboratory. Excellent opportunity for man with aptitude to join growing organization. Duties involve negative handling, color timing, control of tests, answer prints and production. Some knowledge of camera work and animation helpful. Reply confidentially to: M.G., 68-46 Groton St., Forest Hills 75, N.Y.

Motion-Picture Production Worker. Opening exists for talented motion-picture and filmstrip production worker in educational organization located Tidewater, Virginia. Required would be good smattering of experience and comprehension of all elements of creative writing, some motion-picture camera work, supervision of filmstrip production and participation in many phases of motion picture production. Quality of work rather than quantity is considered most important. Permanent position, liberal benefits including group hospitalization, life insurance, free medical service, free retirement. Send complete résumé to James A. Fuller, Director of Employment Colonial Williamsburg, Williamsburg, Va.

Journals Available/Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Available

Complete set of Journals from January 1934 through June 1960. Excellent condition. For sale only as a set. Write: Don Norwood, 1470 San Pasqual St., Pasadena, Calif.

Complete file, Vol. I No. 1 through Dec. 1959 with indexes. Fine condition: $500. James G. Barrick, 15726 Fernway Ave., N.W., Cleveland 11, Ohio.

Complete set of Transactions, except Nos. 6 and 9, and all Journals published to date, including indexes. All in good condition. Price $500. Also extra copies of Transactions Nos. 21, 31, 32. W.W., Hennessey, RFD $2, Pond Ridge, N. Y.

Complete set of Journals from May 1937 to June 1954, including special volumes and membership directories, excellent condition; also Mar., May 1934 and July 1935 issues. Write: Harry R. Lubcke, 2443 Creston Way, Hollywood 28, Calif. HO 9-3266.

Jan.-Dec. 1950; Jan., Feb., Apr.-Dec. 1951; Jan-Mar. 1952. Also available are vols. 6 and 7 of The Television Society (British) covering the period Jan. 1950 through Sept. 1955. Write: Andrew N. McClellan, 65 Hillside Drive, Toronto 6, Ont., Canada.

Dec. 1946, Feb.–Dec. 1947, 1948–1955 complete. All copies in perfect condition; for sale as entire lot only. Write: Joseph W. MacDonald, 2414 Sullivant Ave., Columbus 4, Ohio.

Jan. 1947 to Dec. 1957 complete and in perfect condition. For sale only as a set. Write: Charles J. Marshall, 2816 Royalston Ave., Kettering, 19, Ohio.

Complete set of Journals Jan. 1949 to Dec. 1958. Perfect condition. What offers? Write: J. G. Jackson, 210 Kingsway South, Port Alberni, B.C., Canada.

Assortment of Journals, from 1937 through 1950. Write: Alan Cook, South Londonderry, Vt.

Wanted

Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

Journals—Bound volumes. Write: S. P. Solow, Consolidated Film Industries, Inc., 959 Seward St., Hollywood.

Transactions 6 and 9 ($15 each offered). W. W. Hennessey, RFD #2, Pound Ridge, N.Y.

Jan. 1938, Jan. 1949. (Many other issues are available for trade.) Dept. of Cinema, Univ. of Southern Calif., University Park, Los Angeles 7. Att: Herbert E. Farmer.

Transactions No. 1, 1916 ($5 offered); No. 6, 1918 ($10 offered); No. 7, 1918 ($10 offered). James G. Barrick, 15726 Fernway Ave., N.W., Cleveland 11, Ohio.

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Meeting Calendar

International Scientific Film Association, 14th Congress, Sept. 16–24, Prague, Czechoslovakia.

Deutsche Gesellschaft für Photographie, 1st International Congress on Medical Photography and Cinematography, Sept. 27–30, Düsseldorf, Germany.

International Center of Photography Congress, Sept. 27–Oct. 1, Florence, Italy.

Armour Research Foundation & IRE, 6th Conference on Radio-Interference Reduction and Electronic Compatibility, Oct. 4–6, Museum of Science and Industry, Chicago.

ASCE, National Convention, Oct. 9–13, Boston, Mass.

Electrochemical Society, Meeting, Oct. 9–13, Shamrock Hotel, Houston, Texas.

AIEE Fall General Meeting, Oct. 9–14, Chicago.

NEC National Electronics Conference, Oct. 10–12, 1960, Hotel Sherman, Chicago.

Audio Engineering Society, Oct. 11–14, New Yorker Hotel, New York.

Optical Society of America, Annual Meeting, Oct. 13–15, Somerset Hotel, Boston, Mass.

Fifth International High-Speed Congress and Equipment Exhibit sponsored by the SMPTE, Oct. 16–22, 1960, Sheraton-Park Hotel Washington, D.C.

SPSE Symposium on High-Speed Processing, Oct. 14–15, Shoreham Hotel, Washington, D.C.

Symposium on Space Navigation, Oct. 19–21, 1960, Columbus, Ohio.

Acoustical Society of America, Fall Meeting, Oct. 20–22, San Francisco.

ISA, AIEE, IRE, Sponsors, 13th Annual Conference on Electrical Techniques in Medicine and Biology, Oct. 31–Nov. 2, Sheraton-Park Hotel, Washington, D. C.

AIEE, API, ONR, IRE, Metallurgical Society, Sixth Annual Conference on Magnetism and Magnetic Materials, Nov. 14–17, New Yorker Hotel, New York.

ASME, Annual Meeting, Nov. 27–Dec. 2, Statler Hilton Hotel, New York.

Royal Photographic Society, Scientific and Technical Group Conference, Dec. 7–9, London.

American Association for the Advancement of Science, Annual Meeting, Dec. 26–31, New York.

ISA, Winter Instrument-Automation Conference and Exhibit, Jan. 16–19, 1961, Sheraton-Jefferson Hotel & Kiel Auditorium, St. Louis, Mo.

American Astronautical Society, Jan. 16–18, 1961, Sheraton Hotel, Dallas, Tex.

IRE International Convention, Mar. 20–23, 1961, New York Coliseum, New York.

ISA, 7th National Symposium on Instrument Methods of Analysis, Apr. 17–19, 1961, Shamrock-Hilton Hotel, Houston, Texas.

89th Semiannual Convention of the SMPTE, May 7–12, 1961, King Edward Sheraton, Toronto.

90th Semiannual Convention of the SMPTE, Oct. 2–6, 1961, Lake Placid, N.Y.

91st Semiannual Convention of the SMPTE, Apr. 30–May 4, 1962. Ambassador Hotel, Los Angeles.

92nd Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.

93d Semiannular Convention of the SMPTE, Apr. 22–26, 1963, Traymore Hotel, Atlantic City, N. J.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1960 Journal Part II.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

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